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The Engineer.

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The Engineer

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PUBLIC NOTICES

The Director-General, India Store Department, Belvedere-road, Lambeth, London, S.E. 1, invites TENDERS for :—

SCHEDULE 1.—15 BOILERS for LOCOMOTIVES.

SCHEDULE 2. — 20 LOCOMOTIVE ENGINES and TENDERS, Y.F. Type, metre gauge.

SCHEDULE 3.—About 3000 TONS STEEL WORK for Strengthening of the Kotri Bridge, to be delivered f.o.r. Karachi.

Tenders due as follows :—
Schedule 1, 30th September, 1930.
Schedule 2, 7th October, 1930.
Schedule 3, 31st October, 1930.

Forms of Tender available from the above at a fee (which will not be returned) of 5s. for each Schedule. 5739

Crown Agents for the COLONIES.
COLONIAL GOVERNMENT APPOINTMENTS.

APPLICATIONS from qualified candidates are INVITED for the following POST :—

M/2269.—WATER and SANITARY ENGINEER REQUIRED by the GOVERNMENT of TRINIDAD for the PUBLIC WORKS DEPARTMENT for three years' service. Salary £750, rising to £800 a year by annual increments of £25. Free passages. Candidates, 35-40 years of age, must be A.M.I.C.E. Must have had considerable experience in the preparation of schemes pertaining to Water and Sanitary Works and the execution of such works.

Apply at once, by letter, stating age, whether married or single, and full particulars of qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting M/2269. 5749

Indian Service of Engineers AND INDIAN RAILWAY SERVICE OF ENGINEERS.

The Secretary of State for India in Council will, in the near future, APPOINT FIVE ASSISTANT EXECUTIVE ENGINEERS (including, if possible, one Burman, who will be appointed to the India recruited branch in Burma) to the INDIAN SERVICE of ENGINEERS, and TWO ASSISTANT EXECUTIVE ENGINEERS to the INDIAN RAILWAY SERVICE of ENGINEERS. Except for the Burman appointment, every candidate must be a European British subject of non-Asiatic domicile.

Candidates must have attained the age of 21 years and must not have attained the age of 24 years in the case of those applying for appointment to the Indian Service of Engineers, and 25 years in the case of those applying for appointment to the Indian Railway Service of Engineers, on 1st January, 1930.

The appointments are for Civil Engineers only. Candidates must either (1) have obtained one of certain recognised University Degrees or other Distinctions in Engineering ; or (2) have passed Sections A and B of the Associate Membership Examination of the Institution of Civil Engineers or been exempted by the Institution from such examination ; or (3) have passed the Associateship in Engineering of the City and Guilds Institute (Imperial College of Science and Technology, South Kensington) ; or (4) produced the required evidence that they are otherwise eligible under the Regulations. They should in addition have had about one year's approved practical experience in engineering.

Applications from candidates must reach the India Office not later than 31st October, 1930. Printed forms, together with information regarding the conditions of appointment, may be obtained from the SECRETARY, Services and General Department, India Office, Whitehall, S.W. 1. 5712

PATENTS AND DESIGNS ACTS, 1907 TO 1928.

Notice is Hereby Given that VACUUM LIGHT and POWER, Ltd. (in Liquidation), of 100, Victoria-street, Westminster, London, S.W. 1, SEEKS LEAVE to AMEND the SPECIFICATION of LETTERS PATENT No. 283,681, granted to Charles Scott-Snell and Another for an invention entitled "Improvements in and relating to Thermally-Actuated Motive Devices."

Particulars of the proposed amendment were set forth in the Illustrated Official Journal (Patents), of the 13th August, 1930.

Any person, or persons, may give Notice of Opposition to the amendment by leaving Patents Form No. 19 at the Patent Office, 25, Southampton-buildings, London, W.C. 2, within one calendar month from the date of the said Journal.

W. S. JARRATT,
5720 Comptroller-General.

Chelsea Polytechnic,
MANRESA ROAD CHELSEA,
S.W. 3.

SPECIAL COURSES IN ENGINEERING METALLLURGY

In addition to the Courses in General Metallurgy, arrangements have been made for Special Courses of Lectures and Practical Work :—

(A) Engineering Metallurgy. Syllabus arranged to cover the syllabus of the Institution of Mechanical Engineers' Associateship Examination in Metallurgy.

(B) Heat Treatment of Metals.

(C) Testing and Mechanical Working of Metals.

The above classes are suitable for Engineers, Consultants, Engineering Students, Works Metallurgists.

COURSES BEGIN
22nd SEPTEMBER, 1930.

Full details on application.

Tel., Flaxman 5747. 5714

PUBLIC NOTICES

Borough Polytechnic, Borough ROAD, S.E. 1.
ENGINEERING DEPARTMENT.

Head of Department : J. N. LONG, B.Sc. (Eng.) London, A.M.I. Mech. E.

COMPLETE COURSES extending over Five Years of evening work, leading to the Ordinary and Higher National Certificates :

Engineering Science.
Properties and Strength of Materials.
Heat Engines.
Theory of Machines and Machine Design.
Structural Engineering Drawing.
Structural Steel Work Design.
Reinforced Concrete Design.
Hydraulic Engineering.
Heating and Ventilation.
Refrigeration.
Motor Car Engineering and Design.
Engineers' Quantities and Estimates.
Engineering Economics.
Practical Mathematics.

ENROLMENT : 15th, 17th and 19th SEPTEMBER, 7 to 9 p.m.

Prospectus will be forwarded on application.

J. W. BISPHAM,
5721 Principal.

Robert Gordon's Technical COLLEGE, ABERDEEN.
(CENTRAL INSTITUTION.)

The Court of the University of Aberdeen and the Governors of Robert Gordon's College co-operate in the provision of courses leading to the Pass and Honours Degrees of B.Sc. (Engineering) of the University and to the Associateship of the Colleges in the Departments of :—

CIVIL ENGINEERING,
MECHANICAL ENGINEERING,
ELECTRICAL ENGINEERING.

Full-time Day Courses in Mechanical and Electrical Engineering lead to the Higher National Diplomas in these subjects.

Prospectuses forwarded gratis on application to the SECRETARY and REGISTRAR, Robert Gordon's College, Aberdeen. P56

PUBLIC NOTICES

County Borough of Smethwick.
EDUCATION COMMITTEE.

The Committee invites SCHEMES and TENDERS for the HEATING by ELECTRICITY of its new Secondary School for Boys (accommodation 600), which is shortly to be erected. Further details and the necessary plans may be obtained from

S. CHILDS,
Director of Education.

Education Office,
215, High-street, Smethwick,
9th September, 1930. 5740

Northampton Polytechnic INSTITUTE,
ST. JOHN-STREET, LONDON, E.C. 1.
SCHOLARSHIPS IN ENGINEERING.

An EXAMINATION will be held on SEPTEMBER 25th and 26th at the Polytechnic for the award of the following Scholarships :—

THREE SCHOLARSHIPS in ENGINEERING, value £18 per annum.

These Scholarships are tenable at courses extending over four years in Civil, Mechanical, Electrical or Aeronautical Engineering, and including ten months' practical experience in the works of large industrial firms.

For further information apply to
S. C. LAWS, M.A., M.Sc.,
5715 Principal.

Northampton Polytechnic INSTITUTE,
ST. JOHN-STREET, LONDON, E.C. 1.
EVENING COURSES IN
FUEL TECHNOLOGY AND METALLURGY.

FUEL TECHNOLOGY COURSES for Combustion and Power House Engineers comprise—
LECTURES on the Chemistry of Combustion and the Thermal Efficiencies of Furnaces.
LABORATORY WORK dealing with Calorimetry, Fuel and Gas Analysis, the Examination of Feed Water and allied subjects.

METALLURGY COURSES for Engineers deal with the Extraction, Physical Properties, Commercial Application and Heat Treatment of Ferrous and Non-ferrous metals, while the Laboratory Work includes the Microscopic Examination of those products.

SESSION COMMENCES, SEPTEMBER 22nd, 1930.
Enrolments commence, September 15th, 1930.
Prospectus on application to—
5688 THE PRINCIPAL.

PUBLIC NOTICES

Essex Education Committee.

CHELMSFORD SCHOOL OF SCIENCE AND ART.

A FULL-TIME TEACHER of ENGINEERING is REQUIRED, to commence duties in December, 1930, to be responsible under the Principal for the Engineering Courses and the Engineering Laboratories.

Applicants should have had suitable teaching and works experience and be familiar with Courses leading to the National Certificate. Qualifications in Electrical as well as Mechanical Engineering desirable.

The salary will be in accordance with the Committee's scale plus £25 additional, as the post will rank as one of special responsibility.

Form of application (to be returned as soon as possible) may be obtained by sending a stamped addressed foolscap envelope to E. W. ALSTON, Education Office, 80, Duke-street, Chelmsford. P247

ADMINISTRATIVE COUNTY OF LONDON.

L.C.C. School of Engineering AND NAVIGATION,
HIGH STREET, POPLAR, E. 14.

Principal : J. PALEY YORKE, M.Sc., A.M.I.E.E.

MECHANICAL ENGINEERING DEPARTMENT.

Major courses in mechanical, marine and civil engineering, and minor courses in mechanical engineering will commence on

MONDAY, 22ND SEPTEMBER, 1930.

(ENROLMENT during week commencing 15th September, 1930.)

The major courses are "recognised" for the National Certificates in mechanical engineering both senior and advanced.

Courses are provided for the examinations for A.M.I. Mech. E. and A.M.I.C.E., and for those wishing to join the Royal Navy and Royal Air Force.

Special courses are also provided on Boiler House Engineering, Smoke Abatement and Engineering Economics.

Prospectus and full particulars can be obtained from the Secretary at the school.

MONTAGUE H. COX,
Clerk of the London County Council.
5686

Northampton Polytechnic INSTITUTE,
ST. JOHN-STREET, LONDON, E.C. 1.
EVENING CLASSES
IN
ENGINEERING.

All branches of Civil, Mechanical, Electrical Aeronautical, Automobile, and Radio Engineering.
APPLIED CHEMISTRY.
Fuels, Electro-plating, Metallurgy, &c.
CLASSES COMMENCE 22nd SEPTEMBER.
Enrolments during the week commencing 15th September.
Free prospectus on application to—
S. C. LAWS, M.A., M.Sc.,
5653 Principal.

Bombay, Baroda and Central INDIA RAILWAY COMPANY.

The Directors are prepared to receive up to Noon on Wednesday, 1st October, TENDERS for the SUPPLY of :—

BOILERS FOR LOCOMOTIVES.

Tenders must be made on forms, copies of which, with specification, can be obtained at these offices on payment of 20s. each (which will not be returned).

The Directors do not bind themselves to accept the lowest or any Tender.

S. G. S. YOUNG,
Secretary.

Offices : The White Mansion,
91, Petty France, Westminster, S.W. 1,
10th September, 1930. 5742

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PUBLIC NOTICES

Belfast Harbour.

The Belfast Harbour Commissioners are prepared to receive TENDERS from competent Pump Manufacturers for the SUPPLY, ERECTION and SETTING to WORK, at the Clarendon Graving Docks, Belfast, of THREE ELECTRICALLY DRIVEN PUMPS, viz.:—

2 MAIN PUMPS, and
1 DRAINAGE PUMP,

in accordance with the outline specification, &c., which may be obtained from the Acting Chief Engineer, Mr. W. Y. Chamberlain, A.M. Inst. C.E., Harbour Office, Belfast.

Drawings showing the site of the proposed installation have been prepared and may be inspected at the Engineer's Office.

Sealed Tenders, on the special form provided for the purpose, should be addressed to the undersigned, endorsed "Tender for Electric Pumps," and delivered not later than Wednesday, the 15th October, 1930.

The Commissioners do not bind themselves to accept the lowest or any Tender.

M. J. WATKINS,
General Manager and Secretary.

Harbour Office, Belfast,
6th September, 1930. 5719

Bengal-Nagpur Railway Company, Limited.

The Directors are prepared to receive TENDERS for :—

1104 LAMINATED BEARING SPRINGS.

Specification and form of Tender can be obtained at the Company's Offices, 132, Gresham House, Old Broad-street, London, E.C. 2, on or after Wednesday, 10th September, 1930.

A fee of 20s. will be charged for each copy of the specification, which is NOT returnable.

Tenders must be submitted not later than Noon on Wednesday, 24th September, 1930.

The Directors do not bind themselves to accept the lowest or any Tender, and reserve to themselves the right of reducing or dividing the order.

By order of the Board,
R. GRANT,
Secretary.

5736

City of Carlisle.

18IN. DIAMETER CAST IRON MAIN FROM CUMWHINTON TO CARLISLE.

TENDERS are INVITED from competent Contractors for the SUPPLYING and LAYING of about 4½ Miles of 18in. diameter CAST IRON PIPES and subsidiary pipes from the Service Reservoir at Cumwhinton to Carlisle, and the Construction of Chambers, &c.

General conditions, specification, bill of quantities, form of Tender, &c., may be obtained at the office of the undersigned on and after the 5th September, 1930, when the drawings may be inspected, on payment of Two Guineas, returnable upon receipt of a bona fide Tender and the return of the documents supplied.

Tenders, endorsed "18in. Diameter Cast Iron Trunk Main," must be delivered to my office not later than 10 a.m. on Monday, 29th September, 1930.

The Council does not bind itself to accept the lowest or any Tender and parties tendering must do so at their own cost.

PERCY DALTON,
A.M. Inst. C.E., A.R.I.B.A.,
City Water Engineer.

18, Fisher-street, Carlisle,
29th August, 1930. 5695

Rugby Urban District Water-Works.

FILTERS, &c.
CONTRACT NO. 1.

The Council of the Urban District of Rugby invite TENDERS for RAPID GRAVITY FILTERS, BUILDING and PLANT. The general arrangement drawing and a specification of the work with form of Tender may be inspected and a copy of each may be obtained (on payment of Three Guineas, returnable if a bona fide Tender be made) on application at the office of the Water Engineer of the Council, Benn Buildings, Rugby, and at the offices of Messrs. T. and C. Hawksley, Civil Engineers, 34, Old Queen-street, Westminster, S.W. 1, on and after the 16th day of September, 1930.

Tenders, endorsed "Waterworks," must be addressed to "The Clerk of the Council" and delivered in a sealed envelope at the office of the Clerk of the Council, Benn Buildings, Rugby, at or before Ten o'clock in the forenoon of Wednesday, the 1st day of October next.

The Council do not pledge themselves to accept the lowest or other Tender.

D. E. BIART,
Clerk of the Council.

Benn Buildings, Rugby,
September, 1930. 5737

The County of London Electric Supply Co., Ltd.

BARKING POWER STATION EXTENSIONS, 1930.

The County of London Electric Supply Co., Ltd., are prepared to receive TENDERS for EXCAVATION WORK amounting to about 60,000 cubic yards and the CONSTRUCTION of NEW SIDINGS extending to approximately 3000 lineal yards in connection with extensions to the Power Station at Barking.

The specification, schedule and form of Tender can be obtained on and after 8th September, 1930, from Sir Alexander Gibb and Partners, Queen Anne's Lodge, Westminster, London, S.W. 1.

A deposit of £5 5s. will be charged for the documents, and this will be returned on receipt of a bona fide Tender by the date undermentioned.

Sealed Tenders, endorsed "Tender for Excavation and Sidings," must be delivered to the CHAIRMAN and MANAGING DIRECTOR, The County of London Electric Supply Co., Ltd., County House, 46/47, New Broad-street, E.C. 2, not later than Noon on Tuesday, 23rd September, 1930.

The Company do not bind themselves to accept the lowest or any Tender. 5732

The South Indian Railway Company, Limited.

The Directors are prepared to receive TENDERS for the SUPPLY of—

1. ROLLED STEEL DISC WHEELS AND AXLES (METRE GAUGE) FOR CARRIAGES AND WAGONS;
2. HELICAL AND VOLUTE SPRINGS.

Specifications and forms of Tender will be available at the Company's Offices, 91, Petty France, Westminster, S.W. 1.

Tenders, addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked :—"Tender for Rolled Steel Disc Wheels and Axles," or as the case may be, with the name of the firm tendering, must be left with the undersigned not later than 12 Noon on Friday, the 26th September, 1930.

The Directors do not bind themselves to accept the lowest or any Tender.

A charge, which will not be returned, will be made of 5s. for each copy of Specification No. 1, and of 2s. 6d. for each copy of Specification No. 2.

Copies of the drawings may be obtained at the Offices of the Company's Consulting Engineers, Messrs. Robert White and Partners, 3, Victoria-street, Westminster, S.W. 1.

A. MUIRHEAD,
Managing Director.

91, Petty France,
Westminster, S.W. 1,
10th September, 1930. 5747

LEASE OF IMPORTANT CITY OFFICES FOR SALE.
42, CANNON STREET, E.C. 4.

In consequence of the recent amalgamation of Messrs. MORGAN BROTHERS (PUBLISHERS) LTD., proprietors of "THE IRONMONGER" and "THE CHEMIST AND DRUGGIST," with THE ENGINEER, LTD., proprietors of "THE ENGINEER," the offices of the three journals have been moved to new and more commodious freehold premises which have been acquired at 28-31, Essex-street, Strand, W.C. 2.

The lease of the entire premises, of which the four well-lighted upper floors have been in occupation of Morgan Brothers (Publishers) Ltd., the Ground Floor and Basement being sub-let to the Aerated Bread Co., Ltd., is in consequence for sale.

Alternatively, the four upper floors (which have also an entrance to Garlick Hill), having a total area of about 7,000 sq. ft. would be let.

The premises are in good order and vacant possession can now be had. Rent £2,000 per annum, inclusive of rates.

For further particulars apply to :

Messrs. FAREBROTHER, ELLIS & CO., 29, Fleet Street, E.C. 4,
or to
HENRY BUTCHER & CO., 63 & 64, Chancery Lane, London, W.C. 2.

PUBLIC NOTICES

The Madras and Southern Mahratta Railway Company, Limited,

invite TENDERS for :—

1294 TONS (approx.) STEEL MATERIAL (comprising ANGLES, CHANNELS, FLATS, PLATES, ROUNDS, SHEETS, SQUARES).

Tenders are due in on Tuesday, 30th September, 1930, by 2 p.m. Tender form obtainable at address below ; fee One Guinea, which is not returnable.

The Directors do not bind themselves to accept the lowest or any Tender.

Company's Offices :
25, Buckingham Palace-road,
Westminster, S.W. 5741

Administrative County of London.

The London County Council invites APPLICATIONS for the POSITION of PRINCIPAL of a New Technical Institute at Lewisham High-road, S.E. The Institute will be known as the L.C.C. South-East London Technical Institute and will provide accommodation for :—

(i.) An Engineering and Building Department capable of accommodating the activities at present conducted in the evening at the Goldsmith's College.
(ii.) A Physics, Chemistry and Mathematics Department.
(iii.) A Junior Technical School for Boys.
(iv.) A Women's Department comprising :
(a) A Day Trade School for Girls.
(b) A Home Training School.
(c) Evening Classes in Trade and Domestic Subjects.

The Institute is expected to be ready for occupation in September, 1931, and the Principal will be required to commence full-time duty three months before the Institution is opened. From the date of appointment until the beginning of full-time duty he will be required to serve in an advisory capacity respecting the layout of equipment, the installation of machinery, &c., for which an honorarium will be given of 100 guineas, together with the necessary travelling expenses.

The salary is £850 a year, rising by £50 a year to a maximum of £1060 a year.

Apply to the Education Officer (T.1), The County Hall, Westminster Bridge, S.E. 1 (stamped addressed foolscap envelope necessary), for a form of application, to be returned by Saturday, 11th October.

Canvassing disqualifies.

MONTAGU H. COX,
5718 Clerk of the London County Council.

City of Liverpool.

APPOINTMENT OF CITY ENGINEER AND SURVEYOR TO THE URBAN SANITARY AUTHORITY.

The Corporation of the City of Liverpool invite APPLICATIONS for the POSITION of CITY ENGINEER and SURVEYOR to the Urban Sanitary Authority, at a salary of £2000 per annum.

The officer appointed will be required to devote his whole time to the duties of the office, and will not be allowed to engage in private practice, and all emoluments out of public moneys which may be payable to or received by him will have to be paid to the Corporation.

The officer appointed will hold office subject to the standing orders of the Council, and the appointment will be subject to the provisions of the Local Government and Other Officers' Superannuation Act, 1922.

Canvassing of members of the Council will be regarded as a disqualification.

Particulars of duties may be obtained on application to the Town Clerk.

Applications, stating age, experience, and qualifications, with copies of testimonials (not exceeding three), endorsed "City Engineer," addressed to the Chairman of the Health Committee, under cover to the Town Clerk, Municipal Buildings, Liverpool, must be delivered at the Town Clerk's Office, Liverpool, not later than the 30th day of September, 1930.

WALTER MOON,
Town Clerk.

Town Clerk's Office, Liverpool,
September 8th, 1930. 5723

PUBLIC NOTICES

Manchester Corporation.

CITY ENGINEER'S DEPARTMENT.

APPLICATIONS are INVITED for the APPOINTMENT of an ENGINEERING ASSISTANT at a commencing salary of £360 per annum. The appointment is on the permanent staff, and the successful candidate will be required to contribute to the Corporation's Superannuation Scheme. Candidates must be Associate Members of the Institution of Civil Engineers or have passed Sections A and B of the examination of the Institution.

Applications, stating age, qualifications and previous experience, and accompanied by copies of not more than three recent testimonials, to be sent to the CITY ENGINEER, Town Hall, Manchester, not later than 10 a.m. on Monday, September 22nd, 1930.

Canvassing in any form will disqualify. 5724

Sudan Government Railways

REQUIRE the SERVICES of a DISTRICT LOCOMOTIVE SUPERINTENDENT. Age 25-30, single preferred.

Candidates should have been trained on a British Railway or in a Locomotive Builder's Works and should have good knowledge of the working of a Locomotive Department. A.M.I.C.E. Degree or equivalent. Starting rate of pay £E480 per annum (£E1 equals £1 0s. 6d.). Permanent and progressive post to satisfactory candidate. Strict medical examination. Free first-class passage. Liberal leave if retained.

Apply by letter, giving full details of age, training and experience, to ADVISORY ENGINEER, Sudan Government London Office, Wellington House, Buckingham-gate, S.W. 1, marking envelope "District Locomotive Superintendent." 5731

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

THE ADVERTISERS Under Box No. P109 Beg to THANK all APPLICANTS. The position has now been filled. 5735 A

WANTED, Experienced MANAGER for Malleable Iron Foundry (Cupola). Must be able to produce high-grade Castings to pass up-to-date tests. Present output 30 tons monthly.—Address, in confidence, P238, The Engineer Office. P238 A

INSTRUMENT WORKS.—SEVERAL Experienced PROGRESSIVE MEN REQUIRED, capable organisers, sound controllers of labour, conversant practical methods mass production lines. Only applicants with these qualifications will be considered.—Address, 5709, The Engineer Office. 5709 A

LONDON CONSTRUCTIONAL ENGINEERS REQUIRE INVOICING CLERK, experienced in taking off steel work quantities from shop details and layout plans.—State age, experience, and salary required to Box ZY. 504, c/o Deacon's Advertising Agency, Fenchurch-avenue, E.C. 3. 5738 A

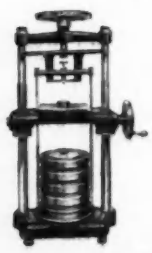
REQUIRED, for a Temporary Post in a Government Department, an experienced MAN for the Production of Dies for Aluminium Die Casting and of Moulds for Rubber Working. Wages 45s., plus 14s. (Engineering advances); total 59s. per week. Ex-Service applicants (if any) given preference.—Write, giving full particulars, regarding experience, etc., to COMMANDANT, Experimental Station, Porton, nr. Salisbury, Wilts. 5704 A

WANTED, an Experienced DRAUGHTSMAN. A thorough knowledge of Hydraulic Cranes and Hoists essential.—Apply, by letter only, stating age and salary required, to THE HYDRAULIC ENGINEERING COMPANY, Chester. 5722 A

DRAUGHTSMAN DESIGNER WANTED, Used to Commercial Vehicle Engines. Experience of High-speed Diesels an advantage.—Address, giving age, experience, and salary required, P248, The Engineer Office. P248 A

AH HERBERT AH

THE HARDNESS TEST FOR DELICATE WORK.



Herbert Small Ball Hardness Testing Machine.

The Herbert Small Ball Hardness Testing Machine is ideal for delicate articles.

A 1 mm. or 2 mm. ball is used, so that material 1/100 of an inch or even less in thickness may be tested without damage, the impression being almost imperceptible to the naked eye.

Hardness numbers are calculated as in the ordinary Brinell test. Catalogue giving full particulars on request.

IMMEDIATE DELIVERY.

ALFRED HERBERT LTD. COVENTRY

SITUATIONS OPEN (continued)

WORKS MANAGER WANTED, also PRESS SHOP FOREMAN, for new Factory near London, specialising in the Quantity Production of Motor Car Parts. Plant consists of Heavy and Light Presses, Machine Shop and Assembly Lines.

Applicants should be about 35 years of age, have good all-round experience and able to take control of labour and production.

Experience of American Production Methods an advantage.

Address, giving age, salary expected and full details of training, experience and positions held, which will be treated in confidence, P234, The Engineer Office. P234 A

FIRST-CLASS SENIOR DRAUGHTSMAN REQUIRED with Sound experience in Design of Bus and Coach Chassis. State age, qualifications and salary.—Address, 5729, The Engineer Office. 5729 A

REQUIRED, by Structural Steel Works in India, FOREMAN, age not over 30. Must have held similar position in this country.—Reply fully, stating age, education, training, present work and wages or salary, to ZG 533, c/o Deacon's Advertising Agency, Fenchurch-avenue, London. 5748 A

SITUATIONS WANTED

A.M.I. MECH. E., Experienced in the Supervision at makers' works of structural steel work, storage tanks for all purposes, piping of all kinds, railway rolling stock, &c.—Address, P243, The Engineer Office. P243 B

COMPETENT EXECUTIVE, Experienced in the organisation and establishment of industries and works on profitable production bases, DESIRES OFFER ; exceptional record.—Address, P7186, The Engineer Office. P7186 B

ENGINEER and WORKS MANAGER AT LIBERTY. Thoroughly up-to-date methods of production, organisation of works and staff, reduction and allocation of costs.—Address, P231, The Engineer Office. P231 B

ENGINEER DESIRES CHANGE. Five Years' works apprenticeship, eight years with small engineering firm on costs, estimates, and designs.—Address, P242, The Engineer Office. P242 B

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For continuation of Small Advertisements see page 4.

A Seven-Day Journal

Labour's Distrust of Science.

IN an address which he delivered on Monday last before the British Branch of the Independent Labour Party, Sir Richard Gregory took "Labour" severely to task for its mistrust in, and misunderstanding of, Science. It was entirely wrong, he said, to confuse the work that was done for the advancement of knowledge with the use that was afterwards made of that knowledge. It was most unjust, too, to attribute to a great group of earnest inquirers, who were not financially benefited by their discoveries, any degrading industrial consequences which might follow as the result of those discoveries. Furthermore, it was most unfair, as Labour did, to confuse investigators in laboratories with the inventors of processes or the manufacturers of machinery, who made profit by their discoveries. Science, asserted Sir Richard, might justly claim that it paid little heed to gains resulting from the exploitation of the rich fields which it opened up. "Labour" had asserted its claim to a full share of the profits of industry, while Science had pursued its inquiries with little consideration of adequate reward. It was possible nowadays to acquire the services of a highly qualified scientific man for a remuneration of less amount than the wages of a municipal dustman. Again, whereas in the workshops and labour organisations the object of unions was to secure increased benefits from the profits of industry, in scientific circles the pursuit of truth and the revelation of new knowledge were the sole standards of achievement. Labour might still be asked to believe in the power of Science to promote both spiritual and material progress. There was a time when intelligent working men idealised science; now, they for the most part regarded it with distrust or were unmoved by its aims, believing it to be part of a soul-destroying economic system.

Manchester's Deputy Electrical Engineer.

ON Friday, September 5th, Mr. A. L. Lunn, deputy chief electrical engineer of the Manchester Corporation Electricity Department, who is taking up an important position with the Underground Electric Railway Companies of London, was presented by the staff of the Department with a desk and pieces of glassware. Mr. H. C. Lamb, chief engineer and manager of the undertaking, in making the presentation on behalf of the subscribers, said they valued Mr. Lunn for his qualities as an engineer and executive officer. He had done great work for the Department, and had helped substantially in bringing it to the high position it occupied. When he came to it twenty-four years ago it had 750 employees, but the number had increased to over 2500. The number of consumers had increased from 6000 to 60,000, whilst the output was ten times what it was twenty-four years ago. Other speakers also paid tribute to Mr. Lunn, who, in reply, said the Manchester Corporation electricity undertaking had always been the finest municipal electricity undertaking in the world. Engineers came from all parts of the country to visit it, and engineers of other countries also inspected the plant when in England.

Grants for Improvement of Harbours and Docks.

THE Ministry of Labour has announced that it is prepared to make special grants in connection with schemes for the improvement of certain small harbours and docks. The step is understood to be bound up with the Government's agricultural marketing scheme. For some time now the Government has recognised the desirability and commercial wisdom of doing all that is possible to revivify the smaller ports of the country, not only as a means of fostering trade, but also of finding work for the unemployed. Accordingly, port and other authorities were invited to prepare schemes for the purpose. Some of the smaller ports have, however, been unable to raise money, even for maintenance and badly required renewal works, save at rates of interest which rendered the expenditure prohibitive. In consequence, equipment and buildings have suffered from neglect and silting has occurred. It has now been decided to help such schemes as are likely to benefit agriculture by providing better, quicker, and cheaper means of transport for foodstuffs and crops generally, as well as for fertilisers, &c. The financial assistance is to take the form of the payment of the whole amount of the interest for seven years on loans raised to carry out approved works, and of half the interest for the rest of the period of the loans, or eight years, whichever is the shorter.

Rural Electrification.

AT a special meeting of the Oswestry Town Council, held on Monday, September 8th, Councillor J. Barlow, Chairman of the Electricity Committee, presented a resolution of the Committee to make application to the Electricity Commissioners to grant a special order extending the Oswestry Corporation's existing area to the rural parishes of Kinnerley, Knockin, Llanyblodwel, Llanymynech, Ruyton of the Eleven Towns, and parts of the parishes of Selattyn, Whittington and Oswestry rural area not included in the borough area. Councillor Barlow said that if the Council did not go forward with the application it was possible that another authority would have the powers, and that the borough undertaking would then be unable to extend beyond its present area. The Chester Corporation had shown an example of extension, and, owing to its enterprise, had secured 140 square miles and 3000 consumers. Several speakers opposed the idea, and Councillor Byrne complained of the lack of information. He protested against being asked to make a momentous decision without having the information which the Electricity Committee possessed, but which it refused to give to the Council. He did not think that it would be in the best interests of the town to take the course suggested by the Committee. Replying to the discussion, Councillor Barlow said the Committee had given the Council the fullest information and it had nothing to hide. Finally, the resolution was carried with one dissentient.

The L.N.E.R. Dismissals.

AT a conference of the National Union of Railwaymen, which was held at York on Saturday last, September 6th, and at which there were present delegates from all parts of the North-Eastern area of the London and North-Eastern Railway, several noteworthy resolutions were passed. The conference expressed its conviction that the recent dismissals were not necessary, and called upon the Union to take such steps as would ensure that an inquiry should be made into the whole administration of the railway. The belief was expressed that, if that were done, staffs would actually be increased instead of diminished, and that the railway itself would be benefited. A further resolution attributed the dismissals to an attempt to discredit the Labour Government. It was also decided that the railwaymen in the North-Eastern area should adhere to their redundancy agreement with the L.N.E.R.—by which men with the shortest length of service should be the first to be dismissed when dismissals became necessary—and that the Company should be made acquainted with the fact that the most strenuous opposition would be offered to any proposed alteration which was not agreed to by the men's representatives. A still further resolution demanded that the Government should, among other things, put immediately into operation the findings of the Washington Conference in their entirety, and should also negotiate with railway companies and contractors so that arrangements might be made by which a proportion of the railway servants, who had been discharged because of the lessening of traffic, might be found employment on works which were being subsidised by the Government.

Conference on Steel Structures Research.

THE Department of Scientific and Industrial Research has within the last few days issued invitations to Local Authorities and certain professional and technical organisations to attend a Conference on steel structures research, which is to be held in the Lecture Theatre of the Institution of Civil Engineers on October 16th next. In a note on the subject which has been prepared by the Department it is explained that the purpose of the Conference is to promote discussion of the work and objects of the Steel Structures Research Committee which it appointed a few weeks ago, and the Chairman of which is Sir Clement Hindley, who will, it is understood, preside at the Conference. This Research Committee was specially set up to review existing regulations for the use of structural steel in buildings and bridges, and to investigate the possibilities of more efficient and economical design. In order to ensure the effective application of the results of the Committee's work, the Department felt that it was desirable to enlist, at an early stage, the interest and co-operation of various bodies concerned. The Conference therefore is intended to provide an opportunity for an exchange of views and for a consideration of various suggestions that have been made, in particular the feasibility of formulating a standard practice in the use of structural steel in building throughout the United Kingdom. In view of the possibility that other bodies besides those to whom invitations have been sent, may wish to be represented at the Conference, they are desired to communicate with the Secretary of the Department, 16, Old Queen-street, Westminster, S.W. 1.

Municipal Electricity.

AT a recent meeting of the Dover Town Council, a recommendation of the Council with regard to terms with the Electricity Board for taking the whole of the electricity of the Corporation in bulk was discussed, and it was decided by fifteen votes to nine not to take the bulk supply. Speaking in favour of the recommendation, the Mayor, Alderman H. E. Russell, said that if the Council did not take the bulk supply it would mean that Dover would have to stand still and see its electricity plant wear out while other towns forged ahead. He had asked the Electricity Commissioners whether the price of electricity would be increased under bulk supply and they had replied that it would not, but might be decreased. Alderman Sir Edwin Farley also spoke in favour of bulk supply and said they had been advised by electrical experts to take it. The Corporation's Chief Clerk had reported that if they did so, they would be £2000 better off in 1935 than they were at present. Councillor F. H. Morecroft, on the other hand, contended that the Corporation's undertaking was doing well, and that they would be acting wisely if they let well alone. The Edmonton Urban District Council, which has hitherto obtained its electricity from the North Metropolitan Electricity Supply Company, has also recently considered the desirability of making a change, and has decided to hand over its powers for the supply of electricity of the district to the London and Home Counties Joint Electricity Authority at the end of the year.

Empire Trade.

THE Manchester Association of Importers and Exporters was established a good many years ago to enable united action to be taken in dealing with shipping companies on all matters connected with maritime trade and, generally, to encourage and assist the overseas commerce of the Manchester district. This Association has now sent a memorandum on trade within the Empire to the Secretary of State for the Dominions with the wish that the views expressed may receive consideration at the Imperial Economic Conference which opens in a few weeks. The memorandum insists that the Conference should be devoid of political significance, but should be representative of the economic trade and finance departments of every Government in the Empire and of employers and employed in the basic industries and of the commerce, shipping, finance and agriculture of each unit in the Empire. It should investigate and report upon the economic problems of the Empire. The memorandum further proposes the establishment of a permanent secretariat which would provide reliable information and data about Imperial trade, and it urges that the natural and intelligent aspirations of the Dominions to possess full economic life, including all classes of manufacture, should be nurtured in conformity with the mutually beneficent advancement of all the component parts of the Empire.

Dalmuir Shipyard.

THE announcement is made that, after the completion of a small amount of shipbuilding which is now in hand, giving employment to some 500 men, William Beardmore and Co.'s shipyard at Dalmuir is to be closed down and dismantled. It has been purchased by National Shipbuilders Security, a body, founded in February last, by firms in the shipbuilding industry to remove redundant shipyards and berths, and generally to exercise the principles of rationalisation in British shipyards. This company has a nominal capital of only £10,000, but has borrowing powers up to £3,000,000. Steps will be taken towards the end of the year to sell the site and the equipment, but shipbuilding will cease. The yard is amongst the largest in the country, and was opened no more than twenty-five years ago for warship construction. Four battleships, several cruisers, and many smaller vessels have been built there for the Admiralty, and, since the war, a few notable liners have been constructed for home and foreign owners. During the war 6000 men were employed, and in normal days, before 1914, between 2000 and 3000 were engaged. It is hoped that occupation for the 500 men that remain will be found in other yards on the Clyde. The sale of the shipyard will not, it is believed, affect adversely the other industries of the company, notably the steel works at Parkhead. It is even anticipated that the reorganisation will enable it to concentrate its resources upon those industries and thereby improve them.

A Marine Airport at Greenock.

THE possibility of utilising the Great Harbour at the James Watt Dock, Greenock, as a site for a municipal marine airport is under consideration. At a recent committee meeting of the Greenock Corporation, Provost Drummond submitted a letter from the Deputy-director of Civil Aviation stating that an officer from the Department, who had inspected the site, had reported that the Great Harbour would constitute an excellent seaplane base. The sheltered portion of the harbour was approximately 1000 yards from west to east and 250 yards from north to south, and, with the exception of the easterly portion, was well protected from all winds. It would be necessary to construct a slipway and to erect a hangar for housing aircraft using the port. The Customs House, the letter went on to explain, possessed an office near by, and arrangements could possibly be made, in the case of marine aircraft coming from the Irish Free State, or elsewhere, to clear passengers and goods there until such time as the service developed sufficiently to warrant additional accommodation. The possibilities of a rapid mail and passenger service by seaplane to Belfast, Dublin, and other places in Ireland, as well as to Oban, Campbeltown, and other towns on the West Coast of Scotland were unlimited and would, undoubtedly, prove beneficial to the future trade of Greenock.

GENERAL VIEW OF THE CITY QUAYS AT BORDEAUX

Improvements at the Port of Bordeaux.

ALTHOUGH many of the French ports had already carried out development work and were providing means for dealing with an increased traffic, the present activity dated from the time when the French Government saw that the only means of securing adequate reparations from Germany was to obtain from that country material of all kinds for the execution of a vast programme of national undertakings. The ports naturally benefited in a large measure from that assistance. With three exceptions they are under State management, and the State made full use of reparations materials to carry out the various programmes of extension. After the hostilities some of the ports found themselves with a great deal of material that had been installed by the British and American armies, and although much of that material is now of little use, the work done and the traffic dealt with during the four strenuous years brought home to the port authorities the possibilities of further developments. Moreover, the character of the traffic underwent a change. The enormously increased oil imports, the growing colonial trade and the hope of diverting more international traffic through France, induced the ports to lay themselves out for dealing with all kinds of cargoes. So long as reparation material was being used, the different ports carried out their programmes irrespective of what was being done elsewhere, but when supplies from Germany practically ceased and the French Government had to provide financial assistance to complete the work in hand, it was found necessary to co-ordinate all the various undertakings and carry them through in a manner to give the most satisfactory results. The schemes had not all worked out according to plan. Some of them were put in hand without knowing what was going to happen in the future. Certain ports had plant and machinery lying idle that could be more usefully employed at others. Therefore, the Association des Grands Ports Français and the Government examined the situation as a whole with a view to specialising the ports and equipping them for the traffic for which they appeared particularly adapted. Before doing anything further, visits were made to ports in Belgium, Holland, Germany and England, and with the information about modern methods now obtained the Government will be able to utilise the funds available

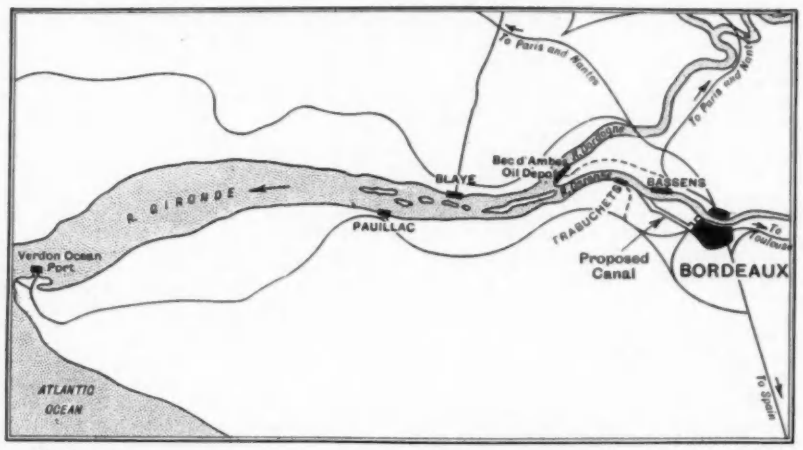


FIG. 1—SKETCH MAP OF THE PORT OF BORDEAUX

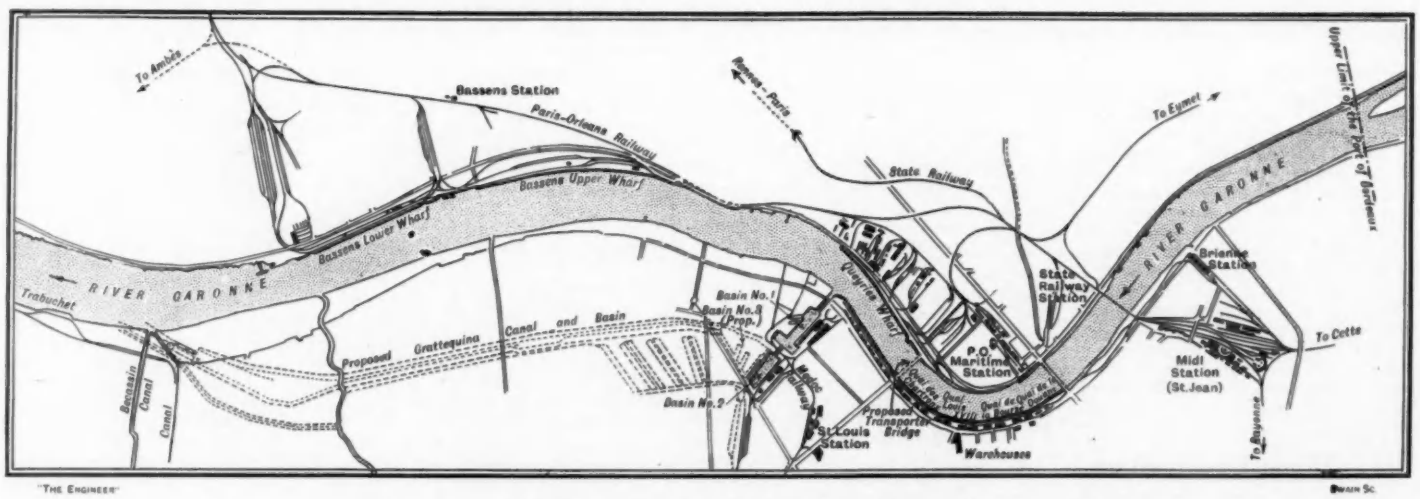


FIG. 2—THE CITY PORTION OF THE RIVER GARONNE

for equipping and extending the ports to the best advantage.

The port of Bordeaux hardly comes within the scheme of specialisation, because its traffic is essentially varied, and its situation makes it a natural centre of traffic with West Africa and South America, while the importation of coal from South Wales and the return cargoes of pit props contribute largely to the port's activity. The creation of industries depending upon the importation of raw material is also a factor in the future prosperity of Bordeaux. A general map showing the position of the port and a plan of the city portion of the river are given in Figs. 1 and 2. The programme of extensions now being carried out was prepared as far back as 1910.

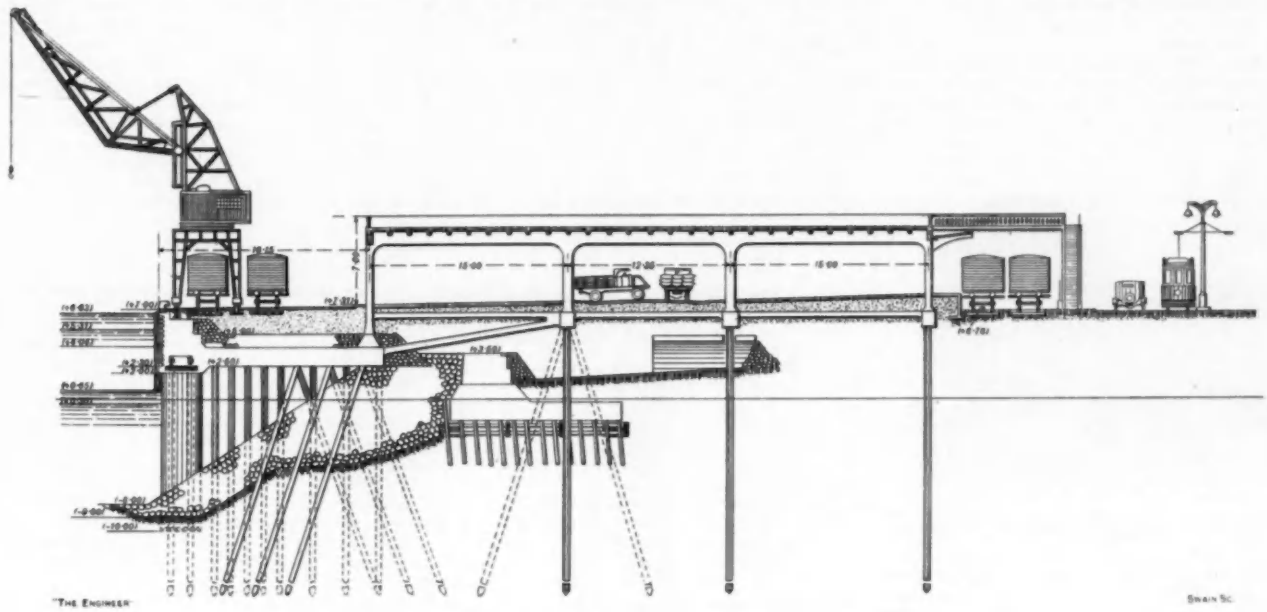


FIG. 3—CROSS SECTION OF THE WORK AT QUAI LOUIS XVIII.

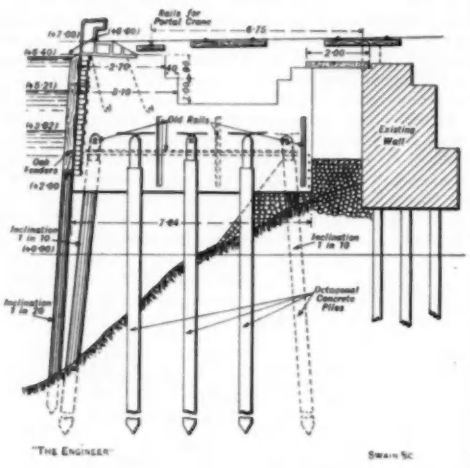


FIG. 4—SECTION OF UPPER BASSENS WHARF

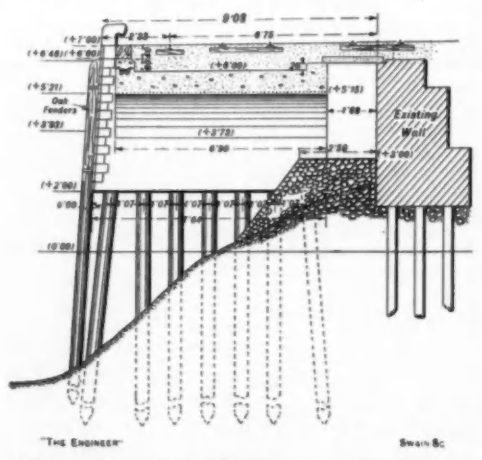


FIG. 5—SECTION OF WHARF THROUGH CROWN OF ARCH

It was well in hand before the mobilisation, and the work then accomplished proved extremely useful during the hostilities, although the programme itself was, of course, entirely suspended. In its main lines the programme provided for the reconstruction of some of the wharves in Bordeaux and the laying out of new basins lower down on the left bank of the river with which they would communicate by means of a wide lock. Then it was decided to reconstruct the wharves that had been built at Bassens during the war and to construct a mole at Le Verdon at the mouth of the Gironde, about 60 miles from Bordeaux, as a port of call for liners which would land passengers there and avoid loss of time in ascending the river. More recently the programme was extended by the creation of an oil port at Bec d'Ambès, at the confluence of the Dordogne with the Garonne, to form the Gironde, and of a floating dock station at Pauillac, about half-way between Bordeaux and the sea.

The wharves in the town of Bordeaux on the left bank of the river have a length of 3300 yards. They are used for liners and for the regular lines of cargo boats. On the right bank of the river the length of the wharves is about 1450 yards. Beyond the wharves on the left bank is the entrance to two basins, which, at some future time, will be increased by three others when the scheme for constructing a canal from the basins to a point lower down the Gironde is carried out. The colonial timber and the coal traffic is confined to the Queyries and Bassens quays, the total length of which is about 4000 yards, while the oil port with its reservoirs is still lower down the river. The total length of all the wharves, including those in the basins, is nearly 7 miles. The equipment of the port with elevating machinery is already nearly complete and comprises about 230 cranes, many of which were installed by the Americans and have been entirely renewed and transformed by the Harbour Board, while others were obtained from Germany on account of reparations. The old hydraulic cranes have been scrapped, and there remain only a few steam cranes, which will soon be replaced. The whole of the elevating machinery will then be operated by electricity. The current is supplied to Bordeaux from the Pyrenees and the Massif Central. The work of extending and equipping the port was pushed forward rapidly from the moment when Bordeaux became a self-governing port in 1925. It shares with Havre and the inland port of Strasburg the distinction of being governed by its own board of directors, all the other ports being managed directly by the State.

The three wharves fronting the quays from the Quai de la Douane to the Quai Louis XVIII. are being extended outwards on the river for a distance of 82ft. This provides so much additional area for the wharves and increases the depth sufficiently to allow vessels of 26ft. draught to draw up alongside. Work is now proceeding on the Quai Louis XVIII., which was built nearly a century ago, when the piles were not driven down to firm soil—see Fig. 3. The piles gave signs of settling, and with the heavy traffic and unstable character of the alluvial bank they were thrust out of the perpendicular in a way that had long caused uneasiness. In the new construction the reinforced concrete wharf takes the form of a wall of piers connected by a platform on piles with the concrete sheds, thereby constituting a rigid assemblage over a considerable area. Under the bed of the river there is a deep layer of coarse gravel over-lying clay. The wall piers are formed of reinforced concrete cylinders or caissons inside of which piles are driven. The cylinders have an outside diameter of 9½ft. and a thickness of 5·2in. Their length is about 40ft. They are constructed on the opposite side of the river and

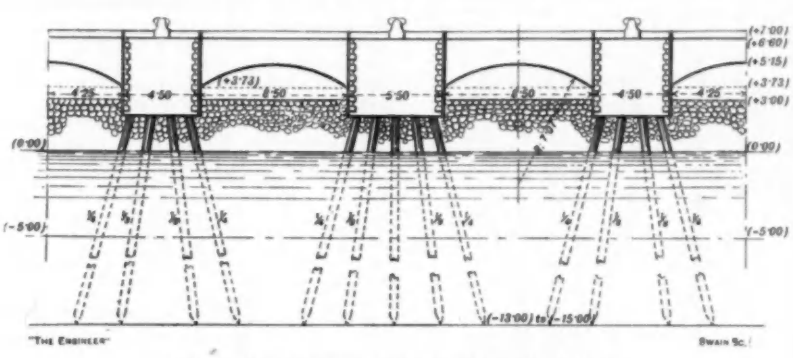


FIG. 6—ELEVATION OF UPPER BASSENS WHARF

carried across by an 80-ton floating crane. Then, while the cylinder is held vertically in position, the mud, sand and gravel are removed from inside it by grabs until it has sunk to about 6ft. below the bed. Four concrete piles are then driven inside and the cylinder is filled with concrete. The piers are spaced at distances of 19½ft. apart between centres. As the piers

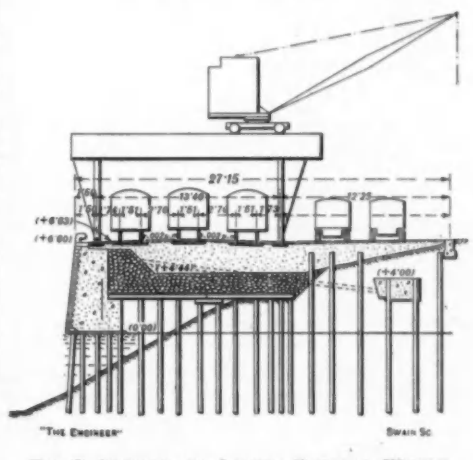


FIG. 7—SECTION OF LOWER BASSENS WHARF

are completed a rail track is extended along them for the pile drivers and cranes. Great care is taken in the preparation of the concrete for the cylinders, the laboratory sending every day a specification depending upon the atmospheric humidity. Between the piers and the old wall with its wood piles out of the vertical, observable in the cross section Fig. 3, con-

crete piles are driven in and any thrust from the bank is taken by diagonal piles. The platform constitutes an integral part of the sheds by means of steel girder sections encased in concrete, which form vertical standards and horizontal and oblique stays. The space reclaimed from the river is partly filled underneath the wharf with rock and coarse gravel.

All the sheds and warehouses forming a continuation of the wharf construction are built to two standard plans. They have single bays about 140ft. deep supported on two intermediate series of piers with pile foundations, joined up at the base with horizontal stays and thrust stays between the first

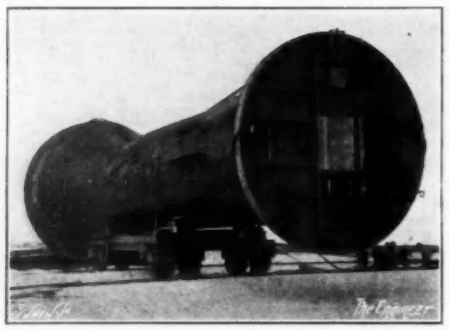


FIG. 8—ORIGINAL TYPE OF CONCRETE CYLINDER

range of piers and the wharf platform. The construction is almost entirely of light steel girder sections encased in concrete. In the two-storey warehouses the upper bay is shortened in order to provide an unloading stage in front, while the lower bay receives the goods for shipment. The ground floor is given a slight slope towards the wharf. The same care in general lay-out, with a view to canalise the traffic and save time, is seen in the new harbour stations which constitute an attractive group of reinforced concrete buildings, all of them forming a rigid extension of the wharf structure. In the Compagnie Générale Transatlantique station for the Casablanca

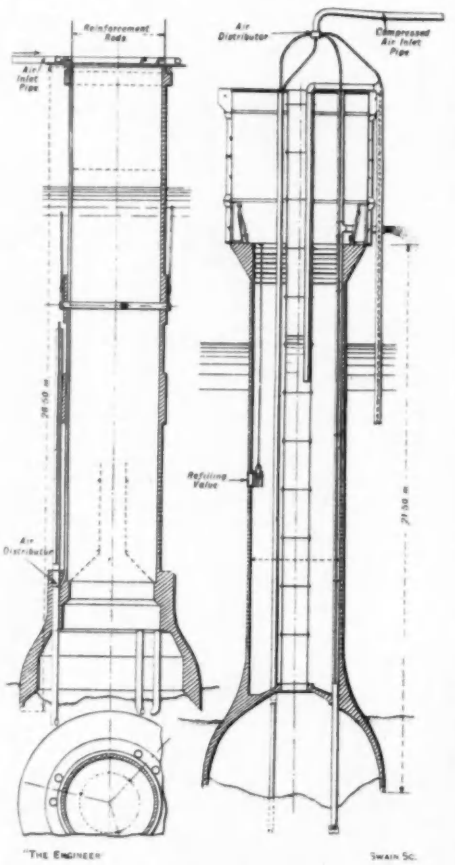


FIG. 9—SECTIONS OF NEW AND OLD CYLINDERS

service, the luggage is received in the lower bay while the upper storey is reserved for the arrival and departure of passengers. The hall is spacious and light, with Customs benches, inquiry offices and a saloon. Another feature of the C.G.T. station is that passengers can go from the ship to the hall under cover. There is a hinged gangway, covered with a canopy, extending from the deck to the hall entrance. The gangway, which was supplied by Germany, is carried on a platform on rails and is electrically-operated, any angle being given to the mobile part, and as the normal tides have an amplitude of about 15ft., this type of gangway is useful.

The port is particularly well equipped with elevating machinery. On the left bank it consists partly of American gantry cranes over three tracks, and mainly of Jeumont 3-ton luffing portal cranes, these latter of a type that provides rapid movements. The girder jib is held from the top of the post by stays and the end of the jib, on rollers, runs up and down the post. On account of their handiness they are employed particularly for the liner traffic. Gantries with travelling cranes are used in the basins for loading pit props, and, in its desire to effect economies, the Harbour Board has for some time past been employing a new form of grab for picking up the props. This is obviously not an easy operation, and much experiment had to be carried out before a form of grab could be devised that would sink into the pile and close in on the full number of props. Wherever possible, the loads on the crane are to be weighed automatically. The Harbour Board aims at getting down handling costs to a minimum.

Before we leave the left bank, although the matter has nothing to do with the port authorities, reference may be made to the Bordeaux transporter bridge. For it an immense tower was erected on each side of the river. The two towers are more than 1200ft. apart, which would make the bridge the longest of this type in existence, and they have been standing for fifteen years. When the late Monsieur Arnodin, who designed the bridge, obtained the concession to construct it, he built the towers before the plans of the girder work were approved by the Ponts et Chaussées. Then the Ponts et Chaussées told Monsieur Arnodin that his girder structures were incapable of resisting the stresses that would be put upon them. Monsieur Arnodin replied that he knew more about his girder work than did the Ponts et Chaussées. Neither would give way, so there the towers remained with the bridge incompleted until after the death of Monsieur Arnodin, when it was decided to carry out the required modifications. The completion of this transporter bridge will render great service to Bordeaux. One of the towers is observable in one of our illustrations.

Other important works are being carried out at Bassens, on the right side of the river lower down, where the new wharves have a total length of 2725 yards. The tides are strong in the Garonne, reaching at times a velocity of 6 knots, and, in the construction, provision had to be made for shocks from the waterside and for movements of the alluvial soil on the banks. Moreover, the work had to be done as economically as possible. The up-river half of the wharf had already been constructed by the French before the arrival of the Americans, who built the second half of it lower down. Work of reconstruction on the French half has consisted in widening the wharf by 29½ft., by constructing a viaduct on concrete piles—see Figs. 4, 5, and 6. A space of 5½ft. has been left between the viaduct and the old wall in order to avoid any pressure from the bank, the space being covered by concrete slabs—Fig. 4. The piers are laid on vertical and inclined octagonal concrete piles. They have a depth of 25ft. and widths alternately of 14¾ft. and 18ft. They support arches having a span of 28ft.—Fig. 6. On the viaduct is a layer of gravel and sand for the rail tracks and the gantries, and it is found possible to dispense with sleepers, and to lay the rails, which are of the flat-bottom type, directly on the sand with spacing tie rods between their webs. This method of construction has, we understand, proved to be quite satisfactory. The construction of the down-river portion of the wharf could not be carried out in the same way. The Americans had erected a temporary wharf on wood piles which it was decided to utilise by cutting them at low water level and driving in others. On the foundation thus provided, a concrete wall, 14ft. wide, was erected to a height of 21ft. The bollards are anchored to concrete blocks embedded in the bank. Behind the wall there is a concrete platform on wood piles, upon which is laid a coarse stone foundation with a deep

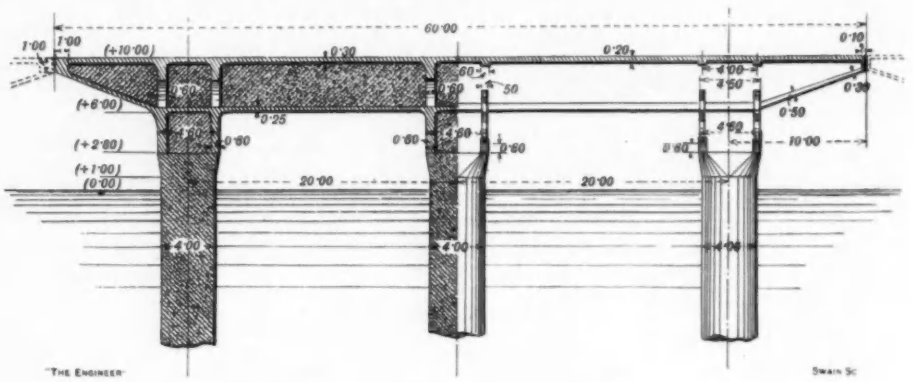


FIG. 10—LONGITUDINAL SECTION OF MOLE

surface of gravel and sand, giving a total width o. 90ft.—see Fig. 7. An unexpected difficulty arose through the presence of a deep marshy patch with flowing water which is being dammed up behind the wall.

The construction of these wharves is not only converting Bassens into a great depôt for colonial timber, coal, grain and other products, but it is also making it an industrial centre which appears likely to grow considerably in the early future. There are storage facilities for 300,000 tons of coal, and it is interesting to observe that Bordeaux has every interest in encouraging the importation of fuel because upon it depends the trade in pit props. The railway consumption of coal is diminishing with the electrification of the Midi and the Paris–Orleans lines, and will in time disappear altogether for that purpose, but this deficit may be made partly at least good by an extension of industrial activity around Bordeaux,

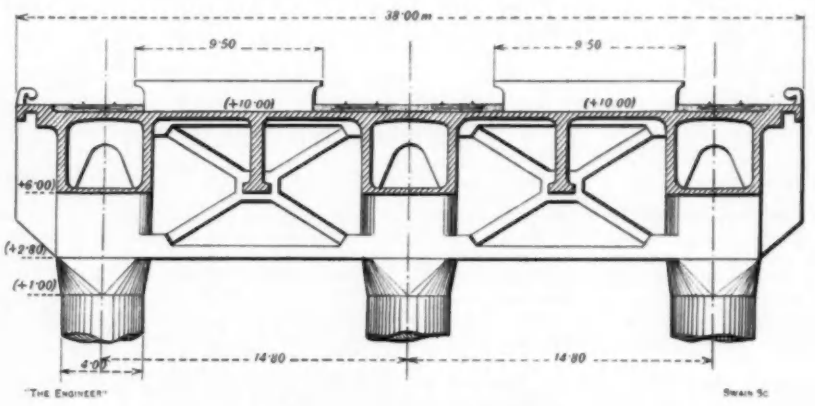


FIG. 11—CROSS SECTION OF MOLE

and particularly at Bassens. There is already a large number of chemical, engineering and other factories at Bassens. Some other proposals have failed of realisation because the cost of electrical energy is too high for manufacturers who find that they are not justified in installing works near raw material supplies unless they can get cheap motive power. After all that has been said about the economy of hydro-electric power distribution, the current is not cheap.

The director of the port, Monsieur François Lévêque, chief engineer of the Ponts et Chaussées, has therefore a scheme for installing a fuel power station at Bassens for the convenience of industrial users, but, for the moment, it is merely a scheme. Coal will, of course, always be needed in the south-west of France, although, with the diminution of railway requirements and the use of oil for marine purposes, the solid fuel will play a less important part in the traffic of the future. Bordeaux can always be depended upon to help the development of coal imports. The grain traffic is growing, and at Bassens there is a 30,000-ton grain elevator, with transporter and plant for the shipment of wheat. Although the works are not yet completed, and sheds and warehouses have to be constructed, Bassens is already dealing with a considerable tonnage of merchandise. The traffic of Bordeaux is, in fact, steadily growing

with the increased facilities offered, particularly with the remarkably complete installation of modern elevating machinery.

At Bassens there are about fifty American 5 and 10-ton travelling cranes on gantries spanning three tracks for handling colonial timber and other goods and three Demag transporters for coal, each capable of unloading and stocking 120 tons an hour. There are other bridge cranes at the coal depôt at Queyries higher up the river. One of the special features of the coal-handling plants at Bassens, which are of the Demag transporter type, is that their riverward sections can be pivoted round 10 deg. each way, so as to cover the entire length of a ship's hold. A novel arrangement for protecting the feeder cables along the wharf from dust and dirt is the covering of the channel with continuous interlocking and overlapping plates, under which rollers with copper sheathing are in contact with the cable and raise the plates with an undulating movement as the gantry travels along. Bordeaux also possesses three floating cranes, one of 100 tons and two self-propelling cranes of 30 tons and 15 tons respectively, while a 60-ton floating crane has been ordered from Germany. The port will also shortly receive from Germany some endless track cranes. Another interesting equipment which the port has secured on account of German reparations is a special form of dredger for keeping open the channel in the mouth of the Gironde. This dredges in three furrows at the rate of 2 to 3 knots at all tides and in fairly heavy seas. In view of the modernising of old plant and the maintenance of the complete equipment of new machinery, the Harbour Board has installed a large engineering shop for carrying out repairs to machinery and its transformation where necessary.

There are only two small dry docks in Bordeaux, although the Chantiers de la Gironde possess on the right bank a dry dock something like 220 m. long, in which, at the time of our visit, the new seaplane carrier, "Commandant Teste," was being fitted out. As Bordeaux is the home port of the Compagnie Sud-Atlantique liners, provision had to be made for the dry-docking of large ships, and two floating docks were obtained on account of reparations, one of 8000 tons and another of 25,000 tons. Since then the launching of the "Atlantique" has shown that even the larger dock is of insufficient capacity, and it is now being transformed to take vessels up to 36,000 tons. The depth of water at the city of Bordeaux itself will not allow of these floating docks being moored high up the river, so that they are stationed lower down at Pauillac, which has become the floating dock station.

One of the most interesting works which are being carried out is the construction of the mole at Le Verdon, at the mouth of the Gironde. It is interesting on account of the method employed for sinking the concrete piers. The idea of making Le Verdon an ocean port of call formed part of the original plan, and its construction became a necessity when the building of the "Atlantique" showed that the increasing draught of ships would not allow of the bigger liners reaching Bordeaux without discharging passengers and some of the freight at Le Verdon. The ability to disembark at the mouth of the river would accelerate passengers' journeys. The bed of the sea at the site for the mole consists of very fine shifting sand, varying in depth from 22ft. to 32ft., overlying a thin layer of gravel, below which is a compact clay about 20ft. thick. The piers will have to be sunk into the clay. The use of caissons was abandoned on account of the cost. The method to be employed, which is due to Monsieur Caquot, chief engineer of the Ponts et Chaussées, and which is now being used for the construction of a viaduct leading to the mole, makes use of the principle of raising liquid with matter in suspension by the action of compressed air. The cylinder forming the sleeve for the pier is made of strongly reinforced quick-hardening concrete, and considerable trouble was experienced before anything like satisfactory results could be obtained. At first, the cylinders, 13ft. in diameter, with a thickness of 5·9in., and originally 70ft. long—see Fig. 8—were made with the shuttering complete, the concrete being poured in vertically and packed with pneumatic hammers. It was found, however, that the complicated reinforcement structure acted as a sieve and separated the aggregate from the cement. The cylinders were then cast horizontally, with better, though still far from satisfactory results, and finally the shuttering was built up as the concrete was poured in. The system adopted by Monsieur Caquot is to carry a tube 3·6ft. diameter down the centre of the cylinder to a bell-shaped bottom forming a chamber. A siphon communicating with the outside keeps the bottom chamber and the central tube full of water. Inside the cylinder are three tubes, 10in. diameter, passing down through the bottom chamber into the sand. They are arranged at 120 deg. apart. Passing down each tube, and concentric with it, is a compressed air pipe which is closed at the lower extremity and perforated just above its lower end with 35 holes of 8 mm. diameter. The compressed air passing through these apertures entrains with it, on its way to the surface, water and sand and ultimately gravel. Occasionally, there has been trouble with boulders and other obstructions, and they are removed by divers descending into the chamber. In a general way the vertical position of the cylinder is adjusted by admitting compressed air to one or other of the tubes as required, so as to remove more sand, but that method has not always succeeded.

The difficulties that have retarded the work, however, have been overcome by experience, and operations are now proceeding satisfactorily. When completed, the cylinders are fitted with blank ends and are towed out and then tilted up and held vertically by cranes. Up till now, the concrete piers have been surmounted by a metallic structure to support the superstructure, but that construction is now being abandoned with the idea of simplifying matters and of accelerating the work, which must be completed a year hence for the service of the new liner "Atlantique." The length of the cylinder is increased from 70ft. to 87ft. with a view to shortening the metallic cap. The weight will be 280 tons, and in order to avoid loss of time in towing the cylinders out they will be taken by a 300-ton floating crane, which has been ordered in Holland.

Fig. 9 shows the two types of cylinders, that on the right being the old type, which is being abandoned. The longer cylinder on the left, now to be employed, is greatly simplified, as compared with its forerunner, by arranging the exhauster pipes outside and taking them through into the bulged bottom. The compressed air pipes pass down through the wall of the cylinder and communicate with the exhauster pipes at their lower extremities. It has been amply demonstrated that so far as the actual sinking of the piers is concerned, the operation is fairly rapid and very economical. The length of the mole is to be 785ft. with a width of 125ft., and as there will be close upon 40ft. of water at low tide, the largest ships will be able to draw up alongside. The mole is to be built in four sections, each section on nine piers, the distance between centres longitudinally being 65½ft. and transversely 48½ft.—see Figs. 10 and 11. The superstructure will be of reinforced concrete. The viaduct connecting the mole with the mainland is to be 1000ft. long. Various views of it under construction are given on page 282. A railway station will be erected on the mole, so that passengers can embark directly for Bordeaux.

In the foregoing are briefly described some of the principal works which are being carried out at Bordeaux and on the Gironde at the present time. More is being done at Pauillac, at the oil port at Bec d'Ambès, and in dredging to provide every facility for an essentially varied traffic. The last year or two has seen a notable increase in the tonnage dealt with, the total for 1929 reaching a record figure of 5,225,000 tons. There is every prospect of its continuing to increase, for the port is under the direction of engineers who are successfully carrying out a programme for dealing economically with the heaviest traffic.

The Interdependence of Science and Engineering.*

By Sir ERNEST MOIR, Bart., M. Inst. C.E., M. Am. Soc. C.E.

SOME branches of engineering are more dependent on exact science than are others, but all must admit dependence on all or nearly all branches of science. I might say, on the other hand, that science in many of its branches has been helped, and urged forward to further investigations, by the engineer stumbling on ground which science had not till then investigated in the particular manner in which engineering had need. By collating results and making them applicable to the future needs of engineering, the scientific worker has on many occasions determined doubtful points and made the future use of discoveries and inventions by engineers and their allied workers possible. The observation of natural phenomena has played a very important part in the advancement of science as applied to industry and to engineering problems of all kinds. The constructing engineer has not the time to investigate exactly the forces of nature with which he has to contend, and he has frequently to cover up his ignorance by the use of "factors of safety" in making his designs, often using larger factors than are called for, and at other times not providing the necessary margins he thought he had allowed for. This is notably the case in connection with bridge designs and stresses arising out of the fatigue of metals and the hammer action of moving loads in bridge floor systems, and the effect of plunging rolling stock thereon.

It was long recognised by engineers that the fatigue of metals under stress arising out of (1) the range of stress, and (2) its reversal, demanded lower maximum stresses to be applied, and the scientist has now so investigated the facts that positive data are available and results can be forecast with accuracy and certainty. There is still a great deal to be discovered in connection with the action of tides and waves and their destructive effect on sea works, many of which fail undoubtedly from the lack of exact knowledge of such action and their reaction on the sea shores where harbours must be built. Just recently we have had an example of the carrying away of years of work at Antofagasta Harbour, Chile, by a series of tidal waves. Yet there is no existing formula extant which would have enabled the civil engineer to forecast this appalling disaster. There ought surely to be some means of collating data for the guidance of civil engineers in the design of marine works, which would save them from having to rely alone on the failures or successes of those who have gone before.

VOIDS.

The influence of air and water-filled voids and the effect they have on many matters that affect engineering practice is not, I think, fully realised. The minuteness of particles and the voids which surround them turn some innocent substances, such as coal dust and flour mill dust, into dangerous explosives, and this is due to the intimate association of the air and its contained oxygen with the minute subdivision of their mass when they are powdered by grinding. The economy of fuel, both liquid and solid, when burning, is greatly enhanced by its fine subdivision, especially if provision for its intimate association with the atmosphere is arranged for.

I propose to give some examples later which have occurred in my own experience and which emphasise the question of the importance played by voids in engineering work.

Another aspect of this subject is exemplified in capillary attraction, or the capacity of certain mixtures of minute particles either in a loose form or in the form of porous solids, which have the power of defying the action of gravity by raising water. In some cases I have known water raised several feet, which seems to me to indicate the existence of a power that so far does not seem to me to have been adequately defined and has some analogy, I imagine, to the diffusion of gases. This power, possessed by some materials, which do not dissolve in water, of acting in an unexpected way on contained fluids, when such fluids are free to move by gravity to lower levels, is due to something not to my knowledge fully explained. I have known water rise up within a glass tube, 1¼in. in diameter, filled with fine sand, composed of decomposed granite—the lower end of which was immersed in a dish containing ¼in. of water—6ft. or 7ft. in a few weeks. This, at first glance, might seem of little moment from a practical engineering point of view, but when subsoils having this characteristics have to be drained so that trenches may be safely sunk therein, the effect of the included water on materials is a serious matter in the construction of engineering works. The lubricating effect set up by the water produces quicksands out of the very fine particles which, when dry, are relatively easy to handle by ordinary trenching methods.

In connection with mixtures of concrete, voids play a very important part in the creation of what is practically artificial conglomerate. Further, the minimum size and the variety of sizes forming the inert parts of concrete mixtures make a great difference to the structure arising out of a mixture of sand and stone—commonly called "the aggregate"—with a varying amount of cement. It is well known that the size of the cement particles themselves make a difference to the necessary hydration, which reunites them after their divorcement by heat and subsequent grinding to a very fine powder. In the case of air-tight or water-tight concrete, it is a matter of great importance that all interstices be filled with cement when it has become hydrated. It forms the adhesive matrix between the other materials, which economise by dilution and form the greater part of the mass.

It is well known that an infinite number of different-sized perfect spheres would ultimately create a mass with no voids at all, if their variety of size be carried to an impossible extreme. In many structures it is an ideal condition of things to get as near as may be practicable to this state of affairs, when, as, for example, an impervious concrete for dams and tanks is desired. Further, in earthen dams and in earthen railway embankments the question of settlement is very largely bound up with the amount of voids left in the material when it is tipped.

During my work in the United States for the British Government during the war—1915–16—I had an interesting experience arising out of the testing of time fuses and the effects of voids thereon. The firm which had made many thousands of this particular fuse—it was called a No. 185 time fuse—had been very accurate in their manufacture up to a point. The timing had been very regular and the percentage of error on proving at the range very small. Suddenly, however, the proving guns told another story, and the timing of the bursting of the shrapnel was distinctly bad. I visited the factory where these fuses were made and went minutely into the possible causes of the change. As to the chemical analysis of the powder, which was compressed into the time-burning rings, there was no change indicated in this analysis and no change in manufacture or in the pressing of it into the time ring. For a time we were all at a loss to account for what was happening. I remembered, however, that British Navy cordite made in England had holes cast through the blocks which go to form propellants for big gun charges. These were carefully proportioned to admit of association of the air surrounding such cast blocks—by perforation—in order to regulate the speed of combustion. I thought there must be something therefore changed in the volume of the voids and of the contained air arising out of the handling of the

* British Association, Section G. Presidential Address. Abridged.

powder when in transit to the factory. I asked the head of the firm whether he had recently changed the method of transport. He said, "Yes, we have." "We have been making an addition to our factory, and while this has been going on we have had to bring the powder in by motor lorries over temporary roads instead of by railway wagon." "Well," I said, "I think this is the secret of the errors in the timing of the fuses you have made, for the powder has evidently been brought in over the rough roads made of tree trunks [called 'corduroy' roads in America] and has been more shaken than it had been when delivered by rail; the voids between the particles have been made less in consequence, and the included air is therefore less in amount, and contact with the particles of powder and the rate of burning is consequently different. This, then, is the possible cause of the burning in the time rings being irregular."

To make a long story short, this was investigated and found to be the case, and when this rough motor transport was eliminated the same powder performed its proper function just as exactly as it had done before this temporary method of transport was introduced and without any change in composition or treatment in the manufacture of the fuses.

The breakwater I have just been constructing in Valparaiso Harbour, Chile, is founded in 187ft. of water upon a sand bank. This bank is deposited by suction dredgers from neighbouring foreshores within 10 miles. It has spread out at its base to over a quarter of a mile in width, and the sand in its passing through this great depth of water has so consolidated itself as it falls upon the bed of the Pacific Ocean, and has so filtered out all its lighter particles on its way, that its consolidation has become very dense; so much so that the fluke of an anchor let fall upon it does not penetrate into its surface. This sand bank has been brought up to a depth below water of 63ft., and graded quarried rock is spread upon its top. First, what is practically quarry rubbish of variable sizes weighing about 2 tons per cubic metre, from which has been picked the larger rubble, is spread on the top of the sand bank; then upon this quarry rubbish selected rock gradually increasing in dimensions as it is gets nearer low water—which weighs about 1·7 tons per cubic metre—is placed. The quarry rubbish, or what is known in Chile as "desmontes," is brought up to 66ft. below low water level, and thereon the larger categories of rock of 2 cwt. to 1¼ tons and from 1¼ tons to 10 tons in weight to 39ft. 6in. below low water are placed. This upper layer, containing the larger categories, is deposited in excess to allow for settlement. It is levelled by divers, and upon this suface are placed blocks weighing 60 tons upon a slope of about 70 deg. to the horizontal and at right angles to the axis of the breakwater, interlocked on the inclined face throughout their depth, so that they can slide down and take up any settlements in the bank on which they rest. Before the 60-ton blocks are placed a period of one year is allowed to elapse so that the whole bank can settle. Notwithstanding this period of one year, the great weight of the superstructure does cause further settlement extending over some months, resulting in a final settlement of about 3ft.

None of the different categories of material appear to have been moved by the very heavy storms, locally known as "northers," on the western coast of South America, neither have any tidal waves disturbed or earthquakes moved, as far as we can determine, this enormous bank to any serious extent.

Valparaiso is the first large breakwater in which a sand foundation has been adopted to so large an extent and there seems to be no doubt that in suitable situations and in a sufficient depth of water smaller material can be used for marine structures than has hitherto been employed.

Experience at Dover Harbour, and also at Valparaiso, indicates that below a level of 45ft., even in structures composed of practically vertical sides with the heavy seas beating thereon, nearly at right angles, there seems little chance of disturbance of relatively small stones.

It should be understood however, in this connection that thought must be given to possible currents arising from any cause whatever. It is well known that stones of considerable dimensions are carried along our London sewers if a velocity of a few feet per second arises.

Only one small movement of the 60-ton blocks in Valparaiso breakwater occurred in an exceptionally heavy storm, and that, I think, was attributable to an interesting and temporary modification of the top courses to assist construction. The movement was very small, and, it adds to the interest to note, it was not on the sea side but on the sheltered side of the breakwater. It was attributable, I think, to the fact that a temporary longitudinal depression was left in the centre of the structure for construction purposes. The pier top has a total width of 45ft. 6in., and only the outer rows of blocks in the top course were placed. Thus a longitudinal channel protected from the sea in which to transmit the blocks, for constructional purposes, to the crane at the outer end of the work was provided. This depression formed a canal when a heavy swell existed and was filled by the sea. None of the joints in the breakwater blocks are cemented or filled with grouts, therefore voids existed between them, into which columns of water flowed. Since water is incompressible, the falling masses of green sea on the surface of this filled canal acted like a hydraulic ram, which transmitted vertical blows from the falling masses of fluid into horizontal pressure between the blocks. The blows moved the top courses of blocks towards the inside by a few inches, but, fortunately, not sufficiently to require extensive operations to put matters right.

Another and similar case occurred in the old Admiralty Pier at Dover, which is faced on both sides with granite blocks. A number of the blocks have been forced out at right angles to the axis of the breakwater by what was clearly equivalent action. In other words, the stone jointing was not full of cement mortar and voids were left. Water accumulated behind the inner ends of these poorly jointed blocks, and the force of the hammer blows reacting from the almost vertical wall created what amounted to a hydraulic ram and so forced the granite blocks out of the face of the breakwater.

The exact action of the sea on structures is waiting the solution of the scientist to determine what forces exist and are exerted by moving masses of water in great storms. The knowledge of the effect of waves of any definite length or height is not determinable with sufficient exactitude by any scientific data that I know of.

The only information the civil engineer can rely on at the present consists of historic facts which are referred to in different publications on the subject of constructed or destroyed breakwaters. All these point to the advisability of putting the top blocks of any breakwater structure in well-cemented joints, and the leaving of no voids, or joints, near the upper levels of these structures. In breakwater design, as in most things, it is a question of compromise, and it is found necessary :—

(*a*) Either to prevent voids entirely where heavy seas are to be encountered near high water level and to a considerable depth below it, by means of rectangular blocks built closely; or

(*b*) To make big irregular masses of artificial rock, such as roughly shaped concrete blocks; or

(*c*) To procure such large rough masses of rock from suitable rock stratifications at not too great a distance or expense.

As to greater depths of a breakwater, however, say, 45ft. to 50ft. below the low water level, where there is no included air possible, the matter of voids and sizes of individual portions of the whole mass of the breakwater bank is not so important.

There is another interesting matter to civil engineers in connection with voids, which arises when dredging materials by means of suction pumping. The ease of movement of the material to be pumped and the consequent economy in pumping are largely influenced by the water contained in and surrounding the particles it is desired to move and lift by suction. Mud or clayey material, for example, will allow the water sucked by the powerful pumps to slide over their surfaces, whereas sand and even lumps of rock the size of one's head, if surrounded by water filled voids, will be moved with relative ease.

Bacteriological and Entomological Sciences and their Influence on Civil Engineering.

Some very large and important works could not have been carried out without great loss of life but for the discoveries of Sir Ronald Ross, Sir Patrick Manson, Bruce and others in connection with the disease-carrying powers of certain mosquitoes, and especially the stegomyia and anopheles mosquitoes which transmit yellow fever and malaria.

In the early days of De Lesepps' effort to build the Panama Canal the death-rate was very high indeed, and did more to make the first efforts a failure than anything else, unless perhaps finance or economics. I do not think Sir Ronald Ross has been recognised by our civil and other engineering institutions as much as he should be for his wonderful work in this connection. When the American Government undertook the construction of the Panama Canal, the success of this great scheme probably owed more to the science of bacteriology than to civil engineering. In my own experience in the construction of the Port of Para in Northern Brazil, I have been much helped by this branch of science. While we did not entirely eliminate yellow fever from our staff, we did reduce it to a small number of cases and had very few deaths. We had also to fight yellow fever in Mexico and Colombia, in connection with civil engineering works, and not without loss among our staff. My firm and the Governments for which we worked owe their thanks to the help of medical science in the widest sense. There are still some fields to conquer in this connection, where we need the bacteriologist and medical scientist to aid us. I refer, *e.g.*, to Varugus disease which caused such destruction of life in the building of the Central Railway of Peru many years ago through the Varugus Valley, which was named after the disease which existed, and still exists.

The latest enemy for which the engineer wants the aid of the parasitologist and scientific medicine is the disease called "Bilharziasis," which is causing great trouble in Egypt and preventing the free movement of that splendid worker, the fellah, to the upper reaches of the White and Blue Niles to assist in the construction of the great dam and canal systems which are now engaging the irrigation engineers. The life history of its mobile germ is being followed out, and we must all hope, from a humanitarian as well as an engineering point of view, for an early and successful attack on this, I think, the latest enemy of the civil engineer and the progress of his work. Black water fever on the west coast of South Africa, sleeping sickness and the tsetse fly are three more cases where the help of the sciences of medicine and bacteriology are invited to assist the pioneer engineer in parts of the world requiring transport facilities.

Caisson Disease.

The civil engineer has been the means of helping himself and his fellows in one special case, that of working in high-pressure air, which has involved serious injury in the past to the men employed in very important work. In this case, while death and injury occurred in a very high percentage only a few years ago, the dangers have now been much reduced, thanks to the civil engineer. Air under pressure is required in the sinking of bridge foundation cylinders and in the driving of subaqueous tunnels, and the resulting illness is commonly called caisson disease, diver's palsy or "bends," the latter name being due to the bodily distortions of the sufferers. This in its essence is a mechanical disease, and for this reason the medical profession did not advance far in ascertaining its cause. It was the civil engineer who through bitter experience and long-continued observation, found a cure. Chance gave me, forty-eight years ago, while at the Forth Bridge, the opportunity to study this disease during the sinking of the caissons which were being built and sunk under air pressure. At a later date the appalling death-rate under the much higher pressures and much worse conditions that attended the construction of the Hudson Tunnel, New York, necessitated something being done to ameliorate the life of those who worked for me, and to make it possible to get the men to face the dangers of carrying on the construction of this, the first subaqueous tunnel built in the United States. The work had been commenced many years before, and much pain and many deaths had occurred, but without any cure having been discovered. Many months of continuous observation on these undertakings enabled me to ascertain certain facts and to devise a scheme of treatment—the use of recompression in a medical air lock—which is now always adopted on undertakings where compressed air is being employed, and with great success. These experiences also led me to discover contributory causes not realised up to that time, namely, among others, the necessity for much purer air than is required in workings at atmospheric pressure, and, further, the benefits arising from stage decompression. By simple reimmersion in high air pressure and by very slow decompression treatment, which is a very gradual withdrawl of the pressure while still keeping the air pure, I was able to reduce the death-rate among the men at the Hudson Tunnel in 1890–92 from 25 per cent. per annum to 1½. In the Blackwall Tunnel in 1893 there were no deaths at all during the whole course of the works. Since those days Professor Haldane, Professor Sir Leonard Hill and Captain Damant, to mention the chief workers in this field, have carried the work of regulated decompression further, and brought the rough discoveries I made and introduced to a more exact scientific basis; and much greater depths of immersion involving higher air pressures are now possible and safe by means of stage decompression. Here is a case where the civil engineer has helped the science of medicine—a return for some of the benefits received from the bacteriologist and medical man.

Economics of Engineering Construction.

The economics of engineering construction naturally divide themselves into several categories. The first of these arises out of the purpose of the engineering works or enterprises. If we take Great Britain as our example, we have public health requirements, including water supply, sewerage, lighting, national road-making, and transport services. These are works in which the financial requirements are based and provided for on the credit of the community using them, issued and financed by the Government or municipality through the investing public, arranged generally by some financial house and, from that house, allotted to the investor by means of a public issue, or they may be provided out of revenue by an Act of Parliament. These are among the easiest financial operations, especially when the borrowing is done by the Central Government, which commands the highest form of credit.

Another category involves enterprises that are to be financed on the basis of possible earnings, and includes the public utilities not yet socialised, such as railways, docks, privately owned harbours, gas and electrical undertakings, and the bulk of the transport facilities, with the exception of roads and bridges. Since the abolition of the tolls, the latter have been undertaken, like works in the sanitary and health categories, by the governmental, county, or other trusts or public bodies.

The next category that interests the constructive engineer and makes for his employment from the financial point of view is the needs of manufacturing and industrial undertakings. These comprise too many categories to attempt to classify them all. It takes, however, a greater faith and more enterprising

spirit to raise money for this kind of work than it does for anything I have mentioned before, and, as a consequence, the financing of factories and ancillary works, immense chemical industries, shipbuilding yards, collieries, coal-handling and loading devices, private harbours and gasworks with the greater financial risks that they involve and the greater probability of obsolescence as well as more rapid depreciation, requires higher rates of interest and provision of larger sinking funds to procure the necessary money.

After the security has been provided and the finance arranged for, the contractor may possibly have to take his payments in scrip. Estimates for foreign work involve questions of exchange, values of local untrained labour, and its efficiency in countries abroad, and other matters entailing considerable risk and requiring a knowledge of the science of economics.

The financing of the works of construction by the contractor may involve deposited guarantees, and will also require money for purchase and transport of plant and machinery, the engagement of staff with a knowledge of foreign languages, agreements as to supplies of material and provision of housing.

Our British joint stock banking system does not lend itself to the provision of such requirements and guarantees, although there is some welcome evidence that this may be altered shortly, as intimated recently in the Press. Foreign contractors, on the other hand, do not have these difficulties to face to the same extent. The German, French, and American banking houses especially have entered into this sort of business for years, and no doubt they share in the profits which arise, and also take some of the risks of losses with the contracting firm.

The responsibilities thrown upon a contractor vary considerably, according to the accuracy or otherwise of his estimate based on the information given to him or otherwise obtained, and the amount of cover he provides for risks that are not taken by the employing Government or company or scheduled by those who advised them. As examples, there are political risks arising from revolutions or wars, threatened or actual, climatic risks including risks of sea action and possible destruction of the work, in some cases even the risks of design—risks arising out of exchange and depreciation of currencies in the country in which the contractor is working—risks of labour disturbances and variations of wage rates either in the country in which he works or arising out of, *e.g.*, a coal strike in England if he is dependent for supplies of fuel from this country; risks arising from the capital required and the interest on such capital; risks of diseases among the staff, either from the nature of the work or the climatic conditions, which may be so bad that the labour required is very difficult, or perhaps non-existent. The available means of access of transport are also important as well as the provision of food and other supplies. Apart from these, in some cases the contractor takes earthquake risks, those of inundation from rivers in irrigation works, the risks of the strata of the foundations on which heavy structures have to be placed, risks of the borings and data handed to him on which to make up his tender being accurate or not. Further, if it is a sea work upon which he is engaged and an immense rubble dam for the base of a breakwater is required, there is the risk of settlement into the sea bed which is nearly always thrown upon the contractor, and sometimes that has involved him in very great loss. Penalties for non-completion in time fall upon the contractor, but generally with fair provisions for extensions for unavoidable causes and *force majeure*. The amount of water to be pumped in deep excavations or in the strata through which tunnels are driven is generally his responsibility, and settlements due to pumping in the surrounding areas, if pumping, in fact, causes settlement in the subsoil—which often happens—is generally another heavy responsibility.

Over and above all this, the efficiency of his supervisory staff and of all his local employees in a foreign country far from his base are matters he has got to take into account in dealing with his valuation of the works. Nor must the consideration of the solvency of the employer be left out of his reckoning. The estimation of the cost of getting suitable raw materials for the structure for which he makes a price depends, for example, among other matters, upon the suitability of rock arising from local stratifications giving, in the case of a breakwater, the large category rubble which goes to build up such banks.

Then if he takes, as he often does in South America, payments in bonds or Government securities, he has to run the risk of a fall in the values of the medium by which he is paid.

I have not even now covered the whole of the possibilities of loss which assail the constructor of large engineering undertakings, either at home or abroad, and for which, after he has assessed to the best of his ability their values and the contingencies arising from them, he must make allowance first in the unit prices of the work he is called upon to do, and, finally, in the gross amount arrived at through the detailed computations. None of the foregoing suggestions are academic. They have all occurred more or less in my forty-five years' experience of doing work for public bodies, Governments and private companies in connection with my firm at home and abroad.

It might be thought, after this recital of the large risks contractors have to take, that they would, of necessity, come to grief sooner or later. That more do not reflects in a large measure their capacity to assess what these things mean, and their knowledge of the science of economics. It is also well known that some, at least, die wealthy.

My own great chief and partner, Lord Cowdray, was one of those who faced with great courage what might come, and never failed to complete anything he undertook, however severely he was called upon on some occasions to back his judgment and make good where nature or man had failed him. It may seem harsh to think or say that he suffered more from man than he did from nature, but, whatever the obstacle, he ultimately triumphed to an unusual degree, and he deserved to for his courage was phenomenal. No risk ever seemed to daunt him, and if after taking every precaution that forethought could suggest, the allowances he made were not sufficient, he faced the music without complaining.

I am the first contracting civil engineer who has been honoured by the British Association and therefore I have thought that you would expect me to include some remarks on things I am specially conversant with, and this must be my excuse for having gone into so much detail on the economics of engineering construction.

I have attempted to indicate the interdependence of the engineer on the science of the physiologist, the bacteriologist, the economist and the all-important science of finance, all of which enable the engineer to carry out his destiny by entering new paths and opening up, by the aid of railways and roads, vast areas to enable them to be made fruitful and suitable habitations for his fellows.

American Engineering News.

Steel Arch Bridge, 1652ft. Span.

A BRIDGE now being built over the Kill van Kull Creek at New York has as its main span a steel arch with a span of 1652ft., or 2ft. more than the Sydney Bridge in Australia. It is of the two-hinged type, and the distance between centres of bearings of the arch shoes is 1675ft. There are two arch ribs, 74ft. apart, each 37½ft. deep at the crown, with upper and lower chords or booms on parabolic curves. The rise from the centre of the bearing to the crown of the lower chord is 274ft., and the height from the water line to the crown of the top chord is 327ft. The floor or deck intersects the arch, being suspended by hanger cables and giving a clear headway of 140ft. above high water. This deck will carry a 40ft. roadway and one footwalk, thus accommodating four lines of travel; but it can be widened for three additional lines or for a double-track electric railway as an extension of the city rapid transit service. The massive concrete abutments were completed in the summer of 1929 and the steel work is now well advanced. The erection is on the cantilever method, but instead of cantilevering the entire half span, temporary supporting frames are built at intermediate points to carry the half arches until they meet. These frames are composed largely of steel to be used later in the long viaduct approaches, 3000ft. and 4000ft. long, which will consist of plate girder spans on concrete piers, 20ft. to 100ft. high. The arch abutments, 107ft. by 133ft. in plan, are founded on solid rock and the mass concrete is faced with granite. This bridge will cost about £3,200,000, of which £1,330,000 will be for the main portion and £1,000,000 for the approaches, the remainder being for land, engineering and administration expenses.

Salt Wells and Mines.

Salt production in the State of Michigan includes both wells and mines. In the former case, water is pumped into the wells to form brine, which is then pumped out, evaporated and the salt refined. In the Detroit rock salt mine, a 30ft. bed of solid salt is worked at a depth of 1200ft., the working being simplified by the fact that the bed is practically horizontal. A shaft of circular section, lined with concrete and 16ft. in diameter, has a rectangular timber framing which provides two hoistways, 6ft. square, the side spaces forming airways. Electric drills are used for the blast holes, the loose "rock" being loaded by electric shovels into narrow-gauge cars of an electric haulage system. A second shaft, used only as a manway, is of rectangular section, but on account of trouble in sinking it was filled solid with concrete, except for two tubes 3½ft. in diameter, partly lined with cast iron pipe. Double-deck circular cages are used. They carry three men on each deck. In the workings, a bottom heading 10ft. high is advanced 20ft., and then the overlying salt, up to the limestone bed rock, is taken out in six rounds. With special cutters a 220-volt drill can put in a 1¼in. hole, 9ft. deep, in 1½ min. Each drill is served by two men, a driller and helper. Large blocks or boulders of salt brought down by blasting are broken up, either with pneumatic picks or by small hand-held electric drills for light charges. Ammonia dynamite of 60 per cent. strength is the explosive, with electric caps, all firing being done at the end of each shift and from the bottom of the shaft. At the shaft the 3-ton cars are tilted by a rotary car dumper, discharging their contents into the 6-ton skips of the shaft.

Power-operated Wedges for Coal Mining.

Although the use of wedges for breaking down coal in mines has been employed in several cases, a novel application of this system is the introduction of wedges operated by power-driven gearing in some coal mines in Colorado. Each wedge consists of three pieces. The middle piece, 10ft. long and of circular section, is made in the form of three tapered surfaces, or like three long cones in series, with a pitch of ½in. per foot. The other two pieces, each 5ft. long, form a split shield or barrel, cylindrical on the outside, but turned on the inside to fit the cones of the centre piece. With the three pieces assembled they form a solid circular member 3⅞in. in diameter. To the end of the long middle piece is welded a threaded bar on which rides a roller bearing nut driven through gearing by an electric motor. A spacing sleeve encloses the screw and bears against a cap which fits over the ends of the two outer pieces and is bored to receive the thin end of the middle piece. When the wedge is inserted in a shot hole drilled to fit it the current is turned on and the nut draws the middle piece forward, giving a maximum expansion or enlargement of 1¼in. in diameter. One 7½ H.P. motor operates three wedges by means of telescopic shafting. With a pull of 2,400,000 lb. on the middle piece or wedge, and allowing 50 per cent. for friction losses, the expanding force would be about 14,000,000 lb. supposing the parts to be strong enough to stand such a force. In practice, about 1½ H.P. is sufficient to expand the bar and break down the coal, the actual force then being about 3,733,000 lb., or 1660 tons. Tests in certain mines have shown an increase of 20 per cent. of lump coal and a decrease of 10 per cent. of slack or fine coal in the output, as compared with coal that is blasted down.

Gas and Oil Pipe Lines.

Manufacture of steel pipe is at a high point, with orders booked for practically the entire capacity up to the end of the year, owing to the extensive activities in the construction of long-distance pipe lines for the distribution of petroleum, petrol and natural gas from their sources to centres of consumption. Lap-welded, seamless and electrically welded pipe is used for this purpose, and about 10,000 miles of trunk or main lines will be laid during 1930. The existing systems comprise 102,000 miles of oil pipe lines, 60,000 miles for gas, and 335 miles for petrol, making a total of 162,335 miles. The new pipe line from the Texas oilfields will give a daily supply of natural gas equal in heat content to 12,000 tons of coal. At present the total annual consumption of natural gas for heating houses is equivalent to 30 million tons of coal, while that used for industrial purposes is equivalent to 15 million tons of coal. Large quantities of gas are also used in electric generating stations. Most of the pipe works are running continuously, twenty-four hours a day, in order to meet the present demand. Experiments have been made with pumping pulverised coal through pipe lines, but the results so far are not very satisfactory. The coal has to be mixed with water to form a sort of slurry, and this water has to be evaporated and the coal made thoroughly dry before it can be used as fuel. One result of the pipe line activity is the revival of the idea of establishing great gasworks at collieries and piping the coal gas for long distances. This scheme, however, has not yet developed from the paper to the experimental stage. The only important petrol pipe line in operation extends from Pittsburgh to near Philadelphia, 335 miles, but similar lines are under construction from Texas and Oklahoma fields to St. Louis, Chicago, and St. Paul, approximately 1250 miles.

Concrete Hauled to Place of Use.

In the enormous development of the use of concrete construction it has been universal practice—and still is almost uniform practice—to mix the concrete at the work and deliver it to wheelbarrows, hand carts, spouts or conveyors for distributing it to the forms. A decided innovation of very recent years is the production of concrete at separate works, like brickworks and ironworks, from which it is hauled to several sites by motor trucks. Although this practice is new, it is already divided into two general processes. In the most usual process the wet concrete is manufactured complete at the plant and is simply transported to the various more or less distant construction works. In a variation of this process the proper proportions of aggregates, cement and water are delivered to the motor truck, the body of which is a revolving mixer in which the concrete is produced during the journey to the construction work or place of use. Both processes have been used on a fairly large scale and apparently with successful results as to the quality and cost of the concrete. A recent plant of the latter kind consists of storage bins and tanks which supply mixer trucks, the bodies of which are steel cylinders of 3 cubic yards capacity. One end of the body tapers in cone shape to an opening 18in. in diameter, through which the materials are charged and the concrete is discharged. Baffle plates assist the mixing as the cylinder revolves during the journey, and the cylinder is tilted for discharging. A tank on the truck delivers the measured quantity of water through a perforated pipe on the axis of the cylinder. A smaller tank provides for washing out the mixer or cylinder as soon as the concrete is discharged. The driver starts the revolving of the mixer at about a mile from the place where it is to be discharged.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

DIESEL.

SIR,—Now that you have revived the question of a name for the class of oil engine commonly known by that of Diesel, why not adopt the word which distinguishes this class of prime mover from all others, namely, the word "injection"? The injection oil engine would then indicate a distinct class regardless of the method of injection. We refer to the two-stroke engine as indicating a class, but there are many methods of applying the two-stroke principle.

There must be very many engineers in sympathy with the arguments you have used, and I think the word "Diesel" should be dropped, because it conveys a confused impression, whereas the word "injection" indicates the class of prime mover without any explanation.

JOHN D. TROUP.

Purley, Surrey, September 5th.

A New System of Riveting.

THERE are certain mechanical details to which engineers have become so accustomed that hardly a thought is ever given to the possibility of their improvement. In the case of riveting, apart from the introduction of

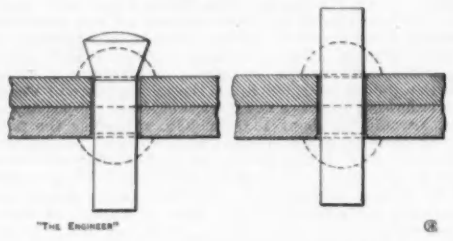


FIG. 1 FIG. 2

hydraulic and pneumatic machinery to economise labour, the rivet itself has remained unchanged since time immemorial. Originally designed to be closed by hand, it has retained its pristine type of shank with a pre-formed head, regardless of the greater latitude of form which the

FIG. 3—HOLDING-UP TOOL FOR PIN RIVETING

development of mechanical methods of closing permit. Universal as it has become, it is by no means without its defects. In the first place, it has to be made beforehand by a hot process, which, at the best, costs money, and, secondly, it is by no means always tight, however carefully and powerfully it is closed. When heated for use the scale formed under the head may prevent that perfect metallic contact so essential for tightness, while, furthermore, the constraint of the head itself may render imperfect the upsetting of the shank required to fill the hole throughout its entire length. The caulking of rivet heads which has to be resorted to to stop leakage from these causes, is an unsatisfactory expedient, absorbing time and labour and having nothing in its favour except that it suppresses the immediate trouble.

The perfection of workmanship now called for, particularly in connection with boiler work, has caused attention to be turned to the details of riveting. One attempt to avoid the difficulties of scale remaining under the head, and of insufficient upsetting of the shank at the head end, resulted in the introduction of the Schuch system of riveting illustrated in Fig. 1. The head of the rivet, in this system, is conical before closing, the object being to allow the scale to escape readily, and to promote the required swelling of the upper end of the shank. Even if both these results could be achieved perfectly, the system would still involve the manufacture of the rivets

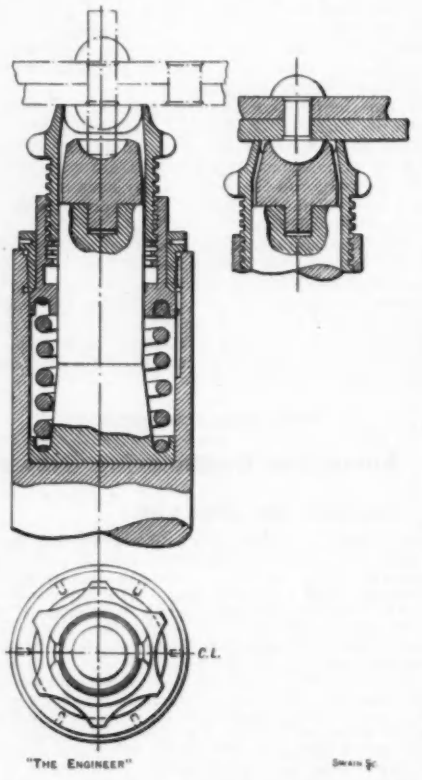


FIG. 4—ARRANGEMENT OF HOLDING-UP TOOL

beforehand. The underlying idea has now been carried to its logical conclusion by the Skoda Works, of Pilsen, Czechoslovakia, by eliminating all previous manufacture of the rivets in favour of a method of using plain lengths of rivet-iron cropped from a bar. The initial and final stages of a rivet put in by the Skoda system are illustrated for comparison in Fig. 2. It is claimed that the absence of any form of head on the heated rivet gives the most favourable conditions possible for getting rid of any scale, and that the complete symmetry of the rivet before closing and the equality of the work done on each end of it leave no reason for the shank not being perfectly upset from end to end.

To make it possible to keep the rivet centrally in the hole so that equal heads are simultaneously formed at the two ends by the riveting machine, it is clear that the latter must be specially equipped. The additional apparatus, however, is very simple and can be attached to any ordinary riveting machine. It consists essentially of a device to locate the rivet-blank axially in the work, so as to ensure an equal size of the two heads. The apparatus is illustrated in the half-tone engraving, Fig. 3, while its construction will be understood from Fig. 4. The snap tool is carried in a holder which fits into a recess in the holding-up head of the riveting machine. It is surrounded by a sleeve, which can be lengthened or shortened at will by a screw connection between its two parts. This sleeve is retained by a gland against which it is normally pressed outwardly by a powerful spring. The projection of the sleeve beyond the snap tool is so adjusted by the screw, that, when the end of the sleeve makes contact with the work and the rivet end is in contact with the snap tool, there is just sufficient of the rivet-blank protruding from the work to enable a head of correct size to be formed. As soon as the rivet-blank begins to shorten under pressure applied by the opposing snap tool, the sleeve yields against its spring and is forced back to the level of the holding-up tool as the rivet is closed, its position then being as shown in the partial drawing in Fig. 4. The two heads are thus formed simultaneously, and the metal of the shank being upset from both ends equally, has every chance to fill the hole. Should it be desired to use the machine for closing ordinary rivets in the usual way, all that has to be done is to unscrew and remove the projecting end of the sleeve.

When using the method of pin riveting, it is important that the work should be steadied during the period when a rivet is being closed, for the steadying influence of one head already existing on the rivet, which facilitates ordinary riveting, is absent. To meet the needs of the

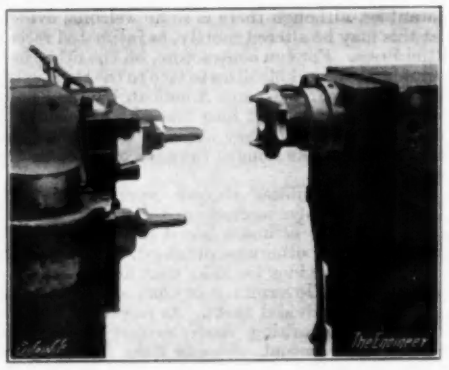


FIG. 7 PIN RIVETING JAWS

case, the Skoda Company have devised the appliance illustrated in Fig. 5. It is mounted on the pressure head of the riveting machine, surrounding the snap tool holder, and its function is to carry a steady pin, which, advancing with the head, enters an adjacent rivet hole and so locates the plates and prevents them from shifting while the tools are closing the rivet. By this means the concentricity of the tools and, therefore, of the rivet heads with the shank of the rivet, is assured. The construction of the appliance is fairly obvious from the illustration. It is bolted to the pressure head by means of the slotted holes shown, which permit of a limited angular adjustment. It has two arms, one horizontal and one vertical, in either of which the block carrying the steady pin can be fixed, according as a horizontal or vertical seam is being worked on. Should the seam be oblique, the slides may be given some intermediate position by rotating the head, which is facilitated by the provision of a wrench-operated worm gear and an angular scale. Scales are also engraved along the slides on the arms for setting the steady pin to the exact pitch of the seam being riveted. A hydraulic riveting machine, with a throat-depth of 6 m., fitted with both the holding-up device and the registering appliance just described, is illustrated in Fig. 6, a nearer view of the jaws being given in Fig. 7.

The advantages claimed for the Skoda system of pin-riveting have, for the most part, already been alluded to. The practical elimination of trouble from scale, from insufficient upsetting and, consequently, from leaky rivets, which require the attention of the caulker, are specially emphasised. The use of short cropped lengths of rivet-bar in place of pre-forged rivets, effects a saving in cost, and at the same time avoids the double heating

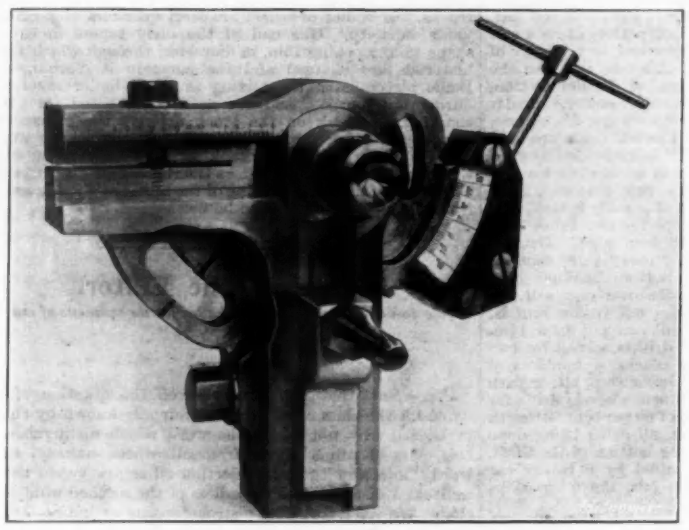


FIG 5—REGISTERING DEVICE FOR PIN RIVETING

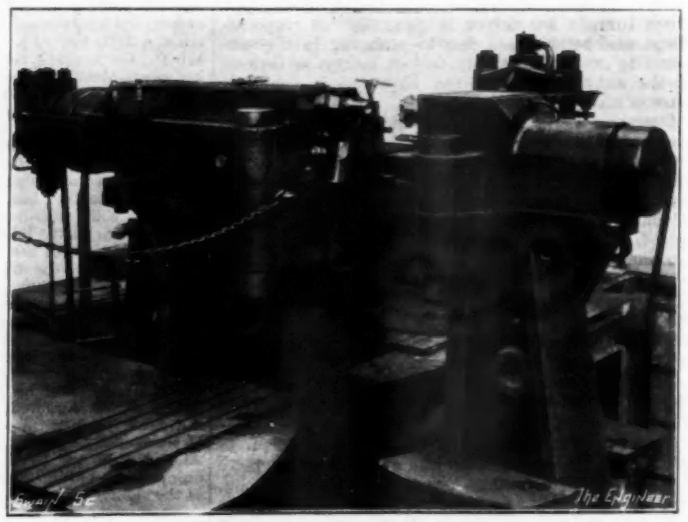


FIG. 6—HYDRAULIC RIVETER EQUIPPED FOR PIN RIVETING

of the material, and the possibility of injury therefrom. The process facilitates workmanship of the highest class, while, at the same time, minimising the cost of production. The Skoda Works employ pin-riveting for all the locomotive boilers they manufacture, the system having been approved by all their customers, including the Administrations of several State Railways. The pins are heated electrically before use. The first year's experience of the system showed a saving of about £800 on the riveting of 60 locomotive boilers, as compared with the ordinary method, and with increasing expertness of the operators, it is anticipated that this result may be improved upon. The process is protected by patents.

Consumption of Fuel in Locomotive Practice.*

By SIR HENRY FOWLER.

THE consumption of fuel in a locomotive fire-box is, the author believes, unique in boiler practice. The conditions under which coal is consumed are in themselves peculiar, but one would like first of all to consider the demands for steam made upon the boiler. These vary almost from moment to moment, and there are comparatively few cases where the demand is constant for more than a few minutes consecutively. In the first place, the demand is dependent, amongst other things, on the location of the stations at which the train is to stop and whilst stationary, naturally there is no demand, but fortunately the ordinary means of draught ceases; nevertheless, when a fresh start is made there must be a full head of steam so as to ensure a good supply in order to allow of a late cut-off and so permit a maximum tractive effort to give as rapid acceleration as possible from rest until normal speed is attained. It is necessary, too, to prepare the fire for a stop at a station, so as to prevent as far as possible the generation of steam when standing and the serious steam loss and inconvenience from noise, &c., due to the safety valves blowing off. There is, too, a point arising out of stopping which is perhaps not always fully recognised. All coals possess a certain amount of "ash," and in some cases this causes a slag, which collects on the fire-bars. The slag in itself varies in character, some setting into hard masses at a comparatively low temperature. Where this occurs during the stop at a station and retards the free passage of air through the bars, it may be a considerable time after re-starting before the fire can again be got into good condition. It is very rarely—practically never—that the stop at a station is long enough to ensure the fire being cleaned properly. In addition to seeing that the fire is in proper condition before coming to a booked stop, it is advisable to see that the water in the boiler is not too high, as it is often advantageous to put on the injector to fill the boiler while standing, so as to prevent "blowing off" with the resultant of waste, as previously mentioned.

Stopping at stations is, however, only one of the cases which causes variations in steam demand. The contour of the line is constantly varying, and with it the demands for power. It may be taken that under normal circumstances on a level railway on a calm day, travelling at, say, 50 miles per hour, the tractive effort required at the tender draw-bar is somewhere in the neighbourhood of 10 lb. per ton. Directly a rising gradient of 1 in 224 is met, however, this is immediately doubled, whilst for a rising gradient of 1 in 100 the resistance is increased by 22·4 lb. per ton, and such gradients are to be found on many of our main lines. The effect of curves is considerable, although their actual effect is dependent on many causes, and their effect has not been very fully investigated.

The wind also has a very considerable influence on the power demanded. This is more marked, however, in the case of a side wind than a head wind. This is due to the fact that a side wind tends to drive the whole train over against one rail, increasing materially the flange friction against this rail.

Now let us consider the method by which coal is consumed in the locomotive fire-box. It is not necessary to give in detail the construction of the locomotive or its boiler, but to consider this as it effects combustion. In this country it is the general, but not universal, practice to arrange the fire-grate of the boiler between the frames. This means that the width available is not greater than about 3ft. 4in. On the L. and N.E. Railway many of the largest and most recent locomotives have the grate carried over the top of the frame and are nearly 7ft. in width. This, naturally, however, decreases the depth of the fire-box. The length of the fire-box is also restricted, as it is necessary, naturally, to allow of the fireman being able to spread the coal over the grate satisfactorily. In order to help in this direction the majority of the grates of locomotive boilers in this country are inclined, at all events, for part of their length. In any case, the greatest length of grate which can be satisfactorily fired is about 9ft. 9in. inside, and assuming the box is 3ft. 6in. wide, this means a grate area of 34 square feet. As a matter of interest the grate area of the three most recently constructed locomotives of the railways of this country are:—"Royal Scot" (L.M.S. Railway), 31·2 square feet; "Lord Nelson" (Southern Railway), 33 square feet; "King George V." (Great Western Railway), 34·3 square feet, these having narrow fire-boxes; whilst the grate area of the "Flying Scotchman" (London and North-Eastern Railway) is 41 square feet with its wide fire-box. In the U.S.A., where the locomotives may be and are much greater, the grate area rises to 90 square feet. Here the use of automatic stokers is universal on the larger types of locomotives; not, however, because they give greater efficiency, but because the amount of fuel to be fed into the fire-box per hour necessitates their use.†

It will readily be understood with so comparatively small a grate area common with English locomotives the combustion of fuel per square foot of grate area is high. This matter is one which has received the closest attention, and it may be taken that under the conditions existing in this country it is not advisable to burn more than 80 lb. per square foot of grate area per hour—although a much higher figure than this is common in America—and it may be taken that any increase leads to very considerable loss of efficiency. Figures for the water evaporated per pound of fuel in America are not readily available, but it may be taken that in this country, with a well-designed boiler and satisfactory firing, an evaporation of 8 lb. to 9 lb. of water per pound of coal may be looked for in British practice. As the author has pointed out elsewhere,‡ in a case taken this gave an efficiency of the boiler of 71 per cent. and an evaporation of 9·5 lb. of water per square foot of heating surface. If 160 lb. of fuel per square foot of heating surface had been burnt the evaporation per square foot of heating surface would have risen to 14 lb., but the efficiency of the boiler would have fallen to 40·2 per cent. and the water evaporated per pound of fuel to 5·75 lb. It will therefore be seen how necessary it is from an economical standpoint not to force the boiler and to see that it is carefully designed and maintained in good working condition.

It is often a matter for wonder how so small a boiler as that of a locomotive can give in many cases steam to provide over 1000 H.P., as is the case with many engines. If the design of a locomotive presents—and it undoubtedly does—certain difficulties, the boiler has certain distinct advantages. One of these is that one can look for it to give much greater steaming capacity than is the case with many stationary boilers. This is probably largely due to the fact that it is constantly moving and being shaken, and this leads to the rapid release of the steam bubbles as they are formed, and to the maintenance of what may be called "wet" surfaces of the metals exposed to heat. This is not always an advantage, for when sodium salts are present in water they cause "priming" much more easily in a locomotive than in a stationary boiler. In the latter they may rise as high as 800–1000 grains per gallon, whilst with a locomotive they may not rise higher than 120–140 grains per gallon. The high and rapid evaporation from the small body of water leads to the carrying away of small particles of water with the steam, although this is, of course, rectified somewhat in the case of superheated locomotives.

The combustion in a locomotive takes place wholly in the fire-box, and the necessary air is fed in two ways, the primary air coming in through the damper or dampers and through the fuel, and the secondary air through the fire-hole door. The air supply must of necessity be adjusted so that in neither case is there too large an excess or deficiency with the resultant loss. As has been said, the fuel is burnt at a high rate per square foot of grate area, and the velocity of the air admitted is also very high and the combustion rapid. In order that there should be as good a mixing of gases as possible, and that there is little passing away of the unburnt combustible gases, a brick arch is fitted across the front portion of the fire-box directly under the boiler tubes. Round this the partially burnt gases from the fuel pass on their way, meeting the secondary air from the fire-hole door, which is fitted with a deflector plate to assist in the necessary mixing and turbulence. The entering air may have a velocity of well over 60 miles per hour, and the deflector tends to throw it under the brick arch, which is built at a rising angle to the horizontal and arranged so that there can be no opportunity of the air from the fire-hole door passing directly over it and into the boiler tubes. If firing is correct and the boiler properly designed, the ideal conditions for economic fuel combustion would seem to be when a very thin smoke issues from the chimney. This should show that there is no excess of air which may arise not only through the fire-hole door being opened too much, but through holes in the fire bed itself. It will be appreciated that the fire-hole door is arranged so that the amount of secondary air admitted through it may be varied according to requirements. Care has also to be taken so that there is never too much green coal on the grate, as in the restricted space there is little chance for the distilled hydrocarbons to be properly consumed, and they escape, not only causing heavy smoke, but also leading to considerable waste.

The method of utilising the exhaust, or portion of the exhaust, by discharging it through a blast-pipe, which by its injector action draws air through the fire and fire-hole door, is well known, but there are several points to which attention may be drawn. A vacuum in the smoke-box of about 6in. of water is usually looked upon as satisfactory. This can be varied, as the size of the issuing orifice of the exhaust is varied. A balance, however, has to be struck, as if the orifice is too large the issuing velocity will be low and it may be that although the "pull" on the fire may be gentle, it may not be sufficient to draw the necessary air through. There have been many devices arranged to vary the size of the orifice according to the cut-off at which the engine is working, as, for instance, with a late cut-off, and therefore large amount of steam to be exhausted per stroke, a large opening, and *vice versâ*. These, however, have not given the success which would lead to their universal adoption. If the orifice is reduced too much a keener draught is the result. This allows of more coal per square foot of grate area being burnt, but with a loss of efficiency, and not only is a greater back pressure thrown on the pistons, but the harder "pull" on the fire causes it to burn in holes and pulls the smaller and lighter portion of combustible matter through the tubes. It will be seen that the orifice has to be arranged so that sufficient coal may be burnt and steam raised and yet the efficiency of the boiler maintained as high as possible. An important point in the efficiency is the size and length of the tubes through which the hot gases pass on their way from the fire-box to the smoke-box and chimney. This is a point to which very careful attention has been given, and particularly by Mr. Lawford Fry, who has embodied his investigation in a small volume published a few years ago.* One has to provide sufficient heating surface and yet not have the tubes so long in proportion to their diameter that the velocity of the gases is unduly retarded. Larger diameters of boiler tubes with the restricted diameter of the boiler barrel, as in a locomotive, tend to give too small heating surface, whilst considerations of weight prevent the lengthening of the barrel itself. It may be taken, however, that a ratio of length to diameter of tubes of 90–100 is generally sufficient. It is a fallacy to imagine that the steaming capacity of a locomotive boiler may always be increased by increasing the number of tubes in the barrel. Under certain conditions this may be the case, but if improperly designed one may be in trouble, from a steam point of view, as the tubes may be so close together as to prevent proper circulation in the barrel, whilst the reduction of the "bridges" between the tubes in the copper tube plate of the fire-box may lead to cracking and the difficulties which arise from this.

There is little that can be said with regard to firing itself which is not self-evident. There are two methods, namely, the one in which the fire is kept slightly hollow, being somewhat thicker at the sides and the one commonly known as the haystack method, in which the thicker fire is down the centre. In both cases the fire should be as thin as possible and yet not in holes. Care must be taken to regulate the secondary air and to watch carefully and anticipate wherever possible the varying demands on the boiler. Little has been done with regard to preheating the air for combustion with ordinary locomotives, although this has been employed on certain turbine locomotives, whilst it is interesting to note that Mr. H. N. Gresley, of the London and North-Eastern Railway, has adopted it on his interesting locomotive, which has a water-tube boiler.

Various methods have been adopted for conserving fuel on a locomotive, such as superheating, feed water heating, the employment of exhaust steam injector, &c., but these seem to be hardly within the scope of this short paper.

* British Association, Bristol, 1930.

† Union Pacific Railroad—4-12-2 type locomotive—has a grate area of 108 square feet.—ED. THE E.

‡ Institute of Fuel Conference, November 21st, 1928.

* "A Study of the Locomotive Boiler," by Lawford H. Fry, published and printed by the Simmons-Boardman Publishing Company in 1924.

The "Model Engineer" Exhibition.

As we have already announced, the *Model Engineer* Exhibition, which is being held in the Royal Horticultural Hall, Westminster, will close to-morrow, Saturday, and we hope that our brief note of last week may have already led some engineers to visit the show, for it is not merely an exhibition of nursery toys attractive to the younger generation, but has a decidedly educative value and should produce a spirit of emulation in the more mature engineer.

This year, which is the twelfth occasion of the exhibition, the models submitted in competition outnumber those of the trade class, and they are correspondingly interesting. To the uninitiated they may appear to be merely the result of painstaking effort and patience, but in reality the production of these models often involves a true engineering instinct in the way of contriving tools and mechanism for making very small parts, while the preliminaries naturally involve the careful study of existing designs. Again, there is a tendency for model makers to club together, to visit one another's workshops, and to exchange experiences, which must all tend towards an extension of knowledge.

It cannot, of course, be expected that the lad should have the aptitude for producing models like some of the exquisite examples shown at the Exhibition, although many of them obviously have the ambition; but the fact that boys may have a high degree of skill of hand is plainly shown on the stand of the Royal Air Force School of Training, Halton Camp, Bucks. The majority of the exhibits are specimens of fitting or exercises with the hammer and chisel and file. The exactness with which the parts have been made can be tested by inverting them in pairs, or even in groups of four, and still obtaining an almost light-tight fit. It is plain that boys who attain this degree of skill will not, as they grow up, tolerate any scamped work. We understand from the authorities that anyone seriously interested may visit the school, and that, with the object of avoiding too military an atmosphere, approximately half of the staff is civilian.

Going round the Exhibition, it is rather noteworthy, this year, that there is a lesser proportion of what one might describe as inventive models; that is to say, models which may or may not be very well constructed, but which demonstrate some idea. On the other hand, the model copies are of unusual excellence. Thus, for instance, there is an eighteen-cylinder aeroplane engine, 15in. in diameter, that is capable of developing 15 brake horse-power, which took six years to make, and an exact scale model of H.M.S. "Hawkins," in which the only omissions are the shields over the machine guns, deliberately left out to disclose the details of the guns. A model of No. 1 locomotive, S.E.R., is interesting for several reasons. It has been made by two brothers with no technical training. It has been to the Exhibition before during progress, and beside it there are exhibited a number of parts which have been scrapped as not coming up to standard. They must have been the cause of many tears.

Small lathes and hand tools are shown on several stands, and although minor modifications have been made in some cases, the machines are so familiar to our readers that it is unnecessary to catalogue them here.

ADDRESSING the annual meeting of the Society for the Promotion of Engineering Education, which was held in Montreal recently, Dr. W. W. Colpitts, consulting engineer of New York City, stated that economic crises of the future, such as that following a period of over-production and depression in the stock exchanges last autumn, may be averted through more active participation of the engineer in the financial world. The engineer, co-operating with the scientist, had brought about the present era of industrial civilisation. Thus the engineer was in a large measure responsible for the benefits and ills brought about through this civilisation. However, he had been denied his proper place in the administration of industry, partly because he did not consider this a part of his work, and partly because the financier thought of him only as an engineer. The engineering mind, the speaker said, was particularly adapted to recognising the weaknesses of industrial organisations. He could with his analytical ability coupled with imaginative power foresee crashes unless remedial measures were taken by the industrialist. In the field of gathering, interpreting, and comprehending statistics and data, the engineer could give invaluable help to industrialists and financiers. Dr. Colpitts illustrated his remarks by citing instances in which members of engineering concerns are now called into conference with bankers, financial magnates and industrial leaders to discuss strictly business matters.

FURNACE OF SUPER-PRESSURE BOILER AT BRADFORD POWER STATION

BABCOCK AND WILCOX, LTD., LONDON, ENGINEERS

(*For description see opposite page.*)

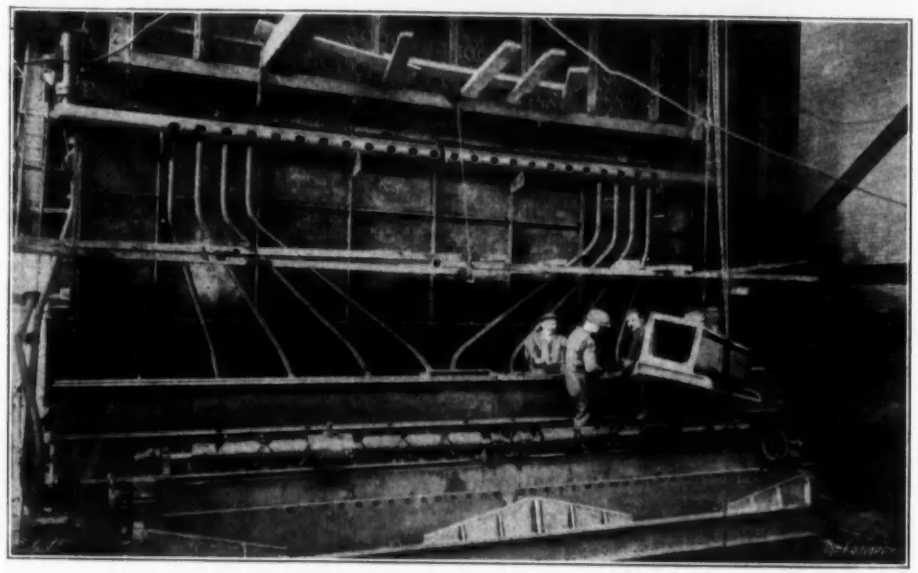


FIG. 12—ERECTION OF SECONDARY AIR DUCT

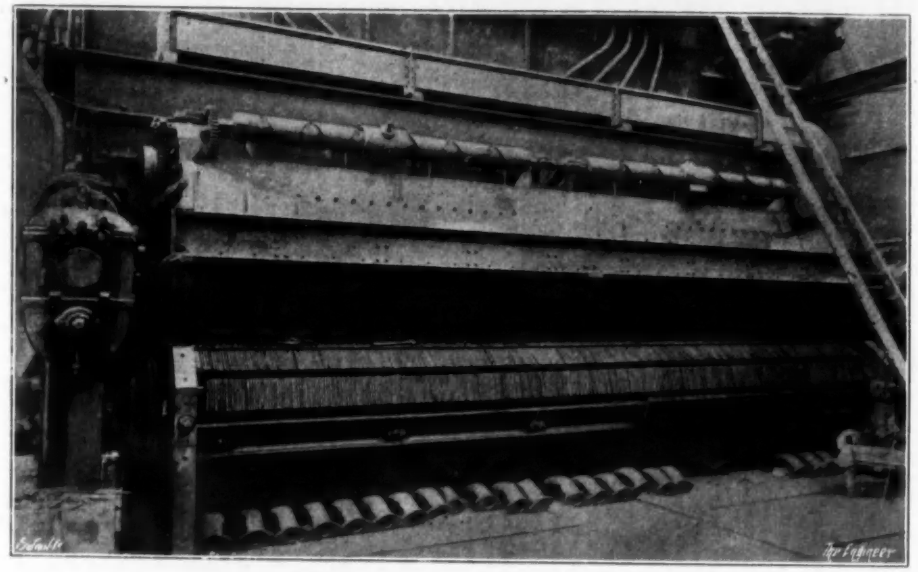


FIG. 13—SECONDARY AIR DUCT AND GRATE IN POSITION

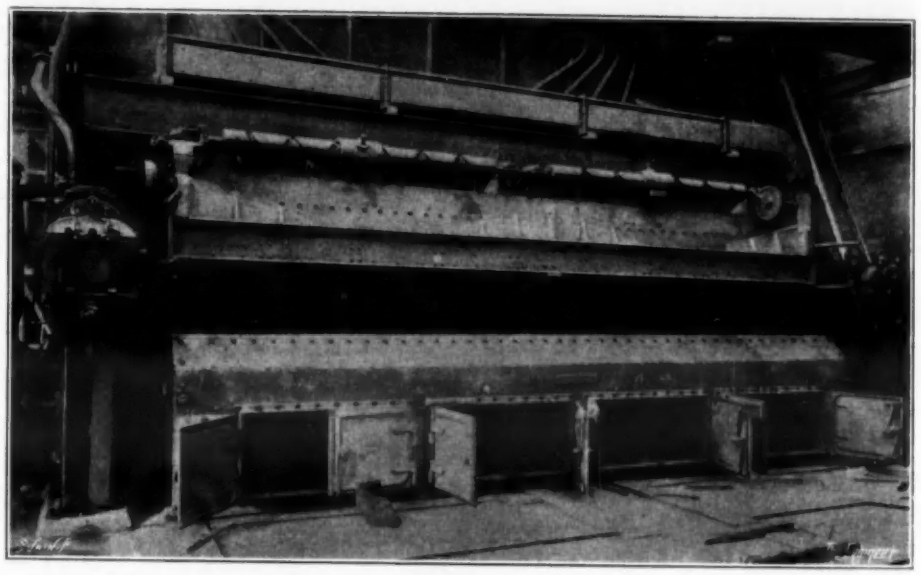


FIG. 14—GRATE CLOSED IN

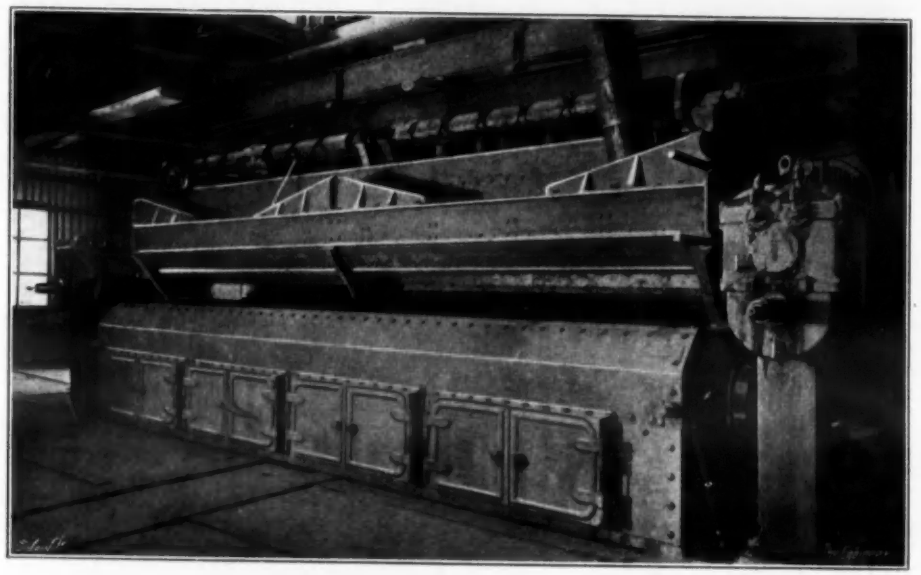


FIG. 15—FRONT VIEW OF FINISHED GRATE

Super-pressure Boiler at Bradford Power Station.

No. II. (*Conclusion*).*

THE STOKER.

THE stoker with which the boiler is equipped is of Messrs. Babcock and Wilcox's latest compartment type. A side view of it was given in the Supplement, which accompanied our last week's issue and other views showing its relationship to the setting are given in Fig. 16. The stoker has a working length of 18ft. from its entrance in the furnace to the dumping bars. It is 21ft. 5in. wide, thus having a total working surface of practically 386 square feet. It is, in fact, the largest single stoker yet in service in Great Britain. The design, however, is suitable for single grates up to 30ft. in width. The stoker bed is made up of narrow cast iron links, threaded on transverse bulb irons at one end and resting on the tops of bearer bars at the other, as shown in Fig. 17, which is from a photograph of a smaller grate of the same type. The narrowness of the links permits a very thorough permeation of the burning fuel by the air coming up through the grate under pressure, while it also minimises the possibility of the burning of the links. The reason for this advantage is easily seen. Each link can only receive heat at its upper surface where it is in contact with the fuel. It is, however, cooled continuously on both sides by the forced draught, so that by making the links thin and sufficiently deep the cooling effect is enough to protect the upper surfaces.

Another feature of the grate, distinguishing it radically from the older types of chain grates, is the absence of any stress in the links themselves. Indeed, as they are only held at one point, no tension is possible in them. The driving strain is taken entirely by the two side and four intermediate chains, which run on rollers and serve to support the bed. The chains are driven by six sprocket wheels on a shaft at the front, this shaft receiving its power from a 4 H.P. motor at each end, driving it through change speed gear. Four speeds are provided. Each motor and gear is capable of driving the grate so that there is a complete driving unit in reserve. The arrangement of the drive is illustrated in Fig. 21, while Fig. 22 gives details of the final worm gear and the clutch. The sides of the grate are fitted with heavy flush-sided cast iron blocks, which travel almost in contact with rectangular forged water-boxes fitted along the furnace sides. An adequate air seal is thus provided, while at the same time there is no possibility of slag formed on the travelling grate tearing away the brickwork at the sides. This was frequently a source of trouble with the older chain grates. A further point which should be mentioned with regard to the grate is its self-cleaning property, which is ensured by an automatic scissors action of the links as they pass over the back of the grate. Every alternate link is so shaped at its heel that it can fall over by gravity a little further than its neighbour on each side. The result is what we have called a scissors action. This is well illustrated in Fig. 18, which shows the position assumed by the alternate links relatively to each other after they have passed under the noses of the dumping bars. The bottom portion of the grate is supported by means of skid bars arranged upon suitable bearers. The Supplement drawing shows the return of the grate towards the underside taking place over cam-shaped castings, which form a continuation of the top rails on which the wheels of the chains run, but that design was abandoned in favour of the usual return sprocket wheels. The proper tension of the grate is maintained by adjusting screws at the front. Should any link break, or need renewal for any cause, it can be replaced in a few minutes. If still in position, it can be broken by a blow of a hammer and removed. Its place is then filled by sliding the other links along the bulb bar, so as to transfer the vacancy to the end of the row, where the fixing of the new link is a simple matter.

The stoker is equally suitable for balanced or simple induced draught, the change from one to the other being effected in a few moments. When running under induced draught the doors along the front of the stoker casing are opened so as to permit the free entry of air. In normal operation, under balanced draught, these doors are, of course, closed, and air is supplied to the fuel by means of the forced draught fan. This air, previously heated to about 250 deg. Fah., on its way through the air heater is delivered to the four compartments under the grate. Its admission to each compartment can be regulated by a damper, so that the rate of burning on the various parts of the grate can be controlled as desired. It should be noted that both under induced and balanced draught conditions the air for combustion always comes into contact with the lower run of the chain. The idle grate links are thus being continually cooled, and the heat abstracted from them is returned to the furnace with advantage to its efficiency. The air inlet valves are arranged so as to be out of the line of falling ash and all riddling valves have been eliminated. The fine riddlings from the front portion of the grate, which contain an appreciable amount of combustible, fall directly into a riddlings hopper, whence they can be conveyed by a travelling runway and returned to this or other stokers. The more completely burned portion of the droppings from the grate and the slag and ash delivered over the dumping bars fall into separate compartments of the main ash hopper. The refuse from this hopper is normally carried away by a drag link conveyor, but, if desired, it can be discharged into trucks on the basement floor.

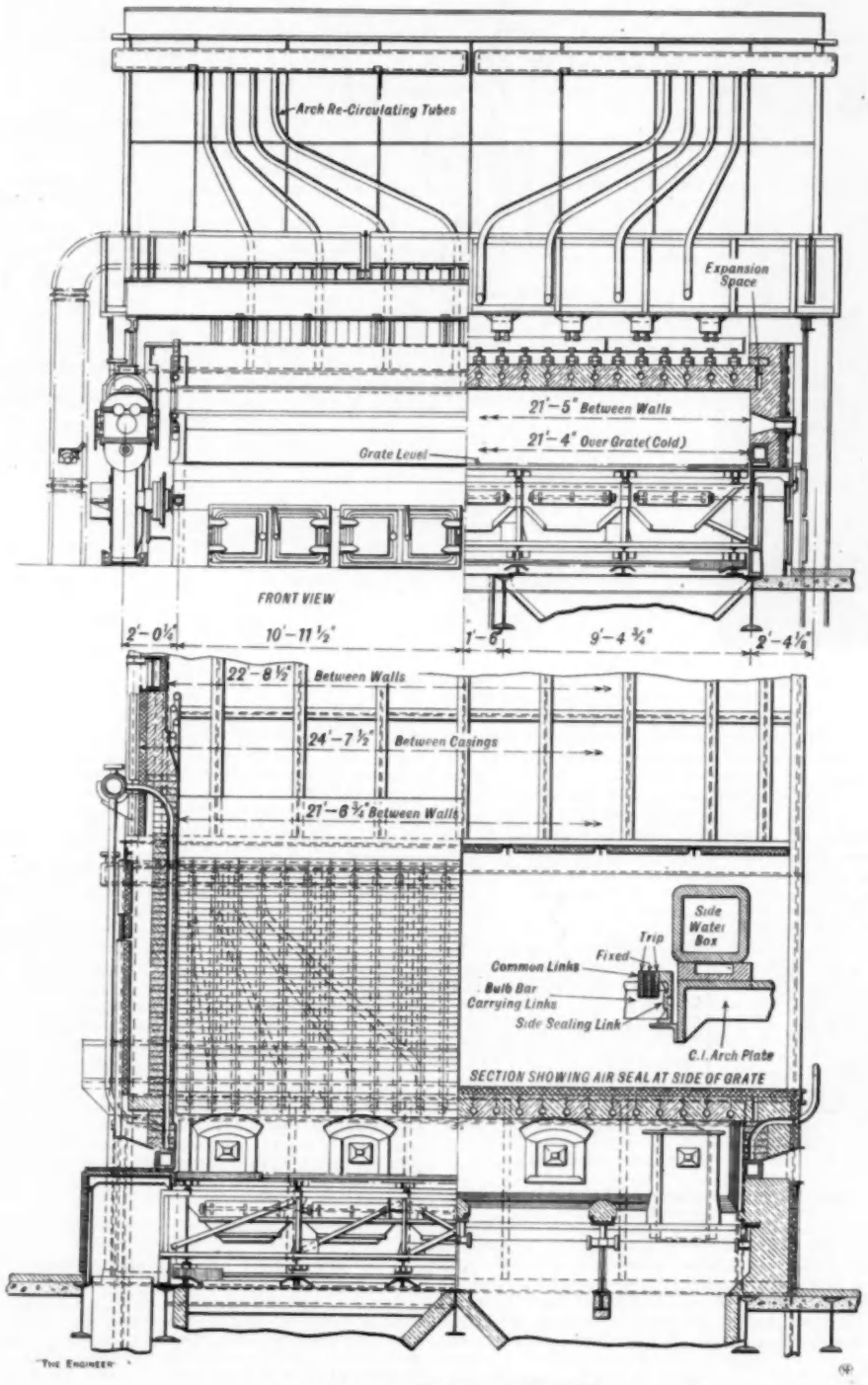


FIG. 16—ARRANGEMENT OF FURNACE

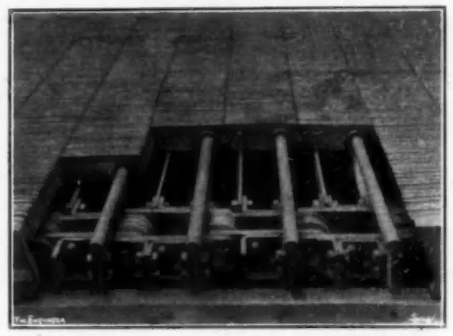


FIG. 17—ARRANGEMENT OF GRATE LINKS

Photographs taken during the erection of the grate are reproduced in Figs. 12, 13 and 14, while Fig. 15 shows its finished appearance. In Fig. 12 the erectors are seen getting into place a section of the hot air duct, which supplies the secondary air to the front of the grate. The view also shows the forged steel headers, from each of which descend four pipes which act as auxiliary circulating connections for the furnace cooling system. In Fig. 13 the secondary air duct is shown in position and the front of the grate is nearly equipped with links. Fig. 14 shows the grate casing in place; in Fig. 15 further progress is evident, while Fig. 19 shows the grate completely finished with the two coal shoots in position. Behind these shoots can be seen the mechanism which maintains them in a continual slow traversing motion so that each shall distribute its coal evenly in the hopper of the stoker. The mechanism, which is a well-known feature of

FIG. 18—BACK END OF GRATE

* No. I. appeared Sept. 5th.

Messrs. Babcock and Wilcox's ordinary practice, consists essentially in a large horizontal shaft, in the surface of which is a spiral groove running from end to end and returning on itself in a closed circuit. In this case there are two such shafts. Sleeves on the shafts engage with these grooves and to each sleeve is attached the end of one of the coal shoots. The shafts rotate slowly and continuously, with the result that the shoots move to and fro in their respective ends of the hopper. The device not only distributes the coal uniformly, but avoids the difficulty, often experienced with fixed shoots, of the larger portions of the coal collecting at each end of the hopper and so tending to cause an uneven fire.

Returning now to matters more directly connected with the boiler proper, the method of control should be mentioned. An instrument board has been provided and erected on the turbine platform for controlling the plant. Included thereon are press-button switches for starting up and adjusting the speed of the stoker, forced and induced-draught fan motors; operating gear for the remote-controlled steam valves; steam and feed water pressure gauges; distance indicating themometers; and combustion control instruments. For the cardinal points of the system recording instruments have been incorporated. For measuring the boiler feed water a Venturi meter of the tele-recorder type has been installed. It may be mentioned, in passing, that up to the present juncture no automatic combustion control has been included. The steam leaves the lower header of the superheater by a curved Y-shaped pipe of 7in. bore, the two branches of the pipe being bolted directly to the main boiler stop valves. The reason for this arrangement lies in the necessity of delivering the steam either to the high-pressure turbine or to the reducing valve already mentioned. The main stop valves are situated in front of the boiler and as near as possible to the superheater. They are operated from a control platform about 9ft. 6in. below. On this platform are situated the hand wheels for manual operation and the electrical gear in connection with the remote operation system. This control gear was supplied by James Tate and Co., Ltd., of Bradford. The drain valves and by-pass valves are also worked from the same platform. The arrangement can be seen in the illustration on our two-page Supplement, which shows the general layout of the whole plant.

The design of the stop valves is shown in Fig. 20. The steam enters by the horizontal branch. The valves, which were supplied by Messrs. Dewrance and Co., are of a simple nature, though every care has been taken to avoid the troubles which the extra high pressure and temperature of the steam might involve. The lower part of the spindle, the valve and the seating are all of nickel alloy, as is also the sleeve through which the spindle slides. The valve is guided axially by wings which work in a nickel bush fixed in the body. The body and cover are both of cast steel. The joint between these parts is made by a narrow corrugated steel ring held in the bottom of the registering recess. Corrugated steel rings of somewhat similar design are used to maintain steam-tightness between the valve and pipe flanges, and indeed throughout the whole of the high-pressure pipe work. They are, however, in general, not placed in recesses, but held central by the ring of bolts around them.

As regards other auxiliary apparatus it may be mentioned that direct-current adjustable speed motors, with starters of the automatic contactor type, are employed for driving the forced and induced draught fans and the stokers. The latter are equipped with coal meters, supplied by the Lea Recorder Company, of Manchester. Cope's regulators are used to control the feed to the boiler, and an automatic water level indicator has been furnished by James Gordon and Co., of London, for giving remote indications of the water level. This is a new piece of apparatus which is operated on a principle similar to that of the Cope's regulators. The flue gases, before being discharged to the chimney, are passed through a grit collector of the cyclone type, constructed by Davidson and Co., of Belfast.

We are indebted to Mr. Thomas Roles, the City Electrical Engineer and Manager of the Bradford Corporation, for permission to describe this notable example of good and courageous modern engineering, and for giving us every facility to inspect the plant in his Valley-road power station. Our thanks are no less due to the builders, Babcock and Wilcox, Limited, for the drawings and details which they have allowed us to publish in the interests of our readers. We have confidence that the plant will fully justify the initiative of Mr. Roles on taking a step so far in advance of current practice. The work that has been carried out at Bradford shows that we have both engineers and manufacturers with the spirit of enterprise which gave us our original lead in steam engineering, and it is to be hoped that their example will encourage others to maintain the great traditions.

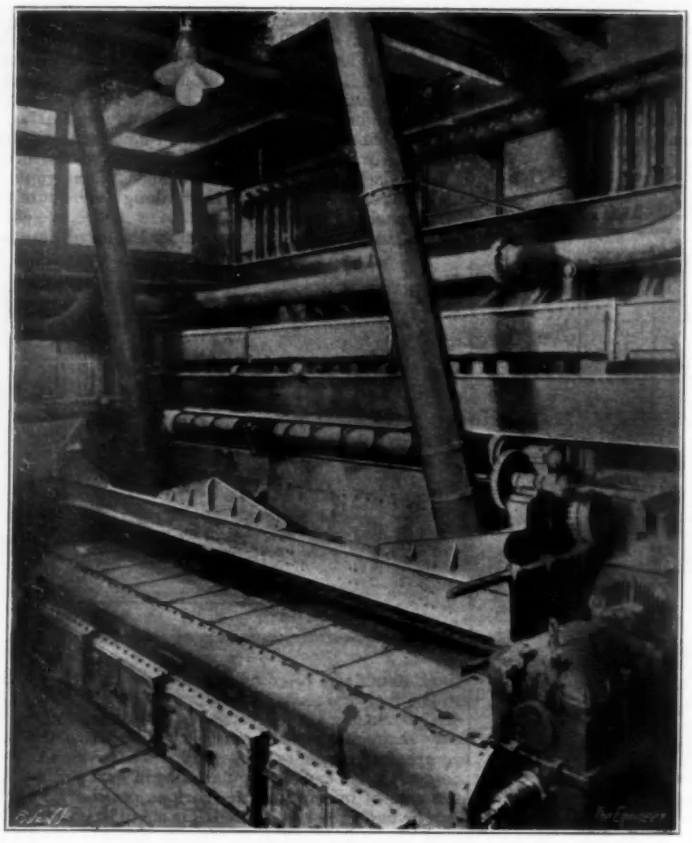


FIG. 19—COMPLETED GRATE WITH COAL SHOOTS IN PLACE

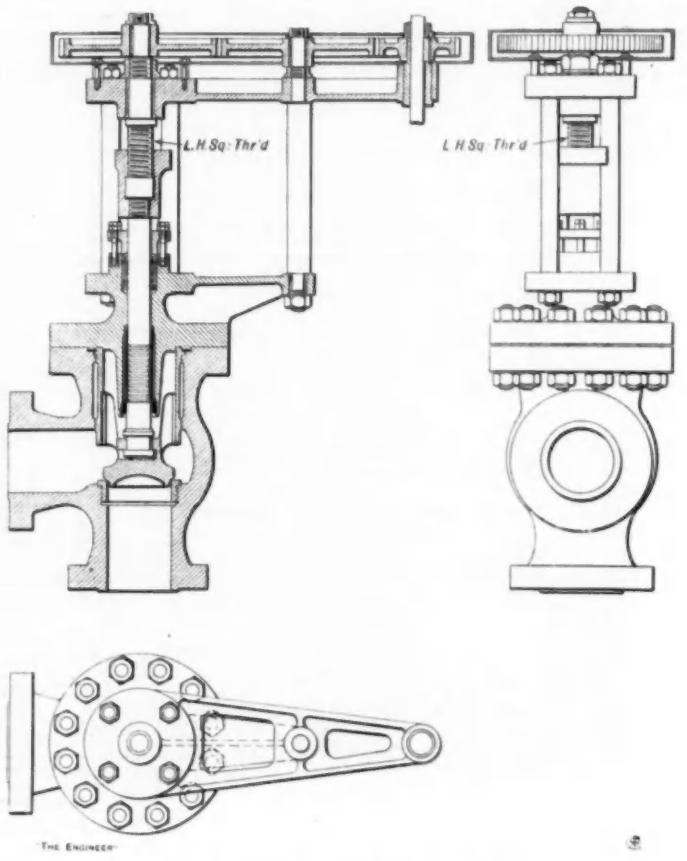


FIG. 20—SUPER-PRESSURE STOP VALVE

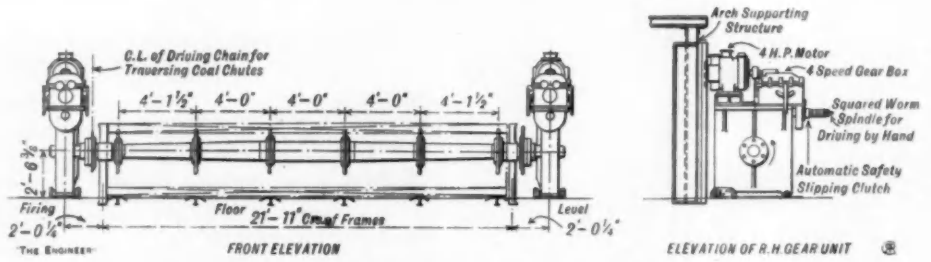


FIG. 21—ARRANGEMENT OF GRATE-DRIVING MECHANISM

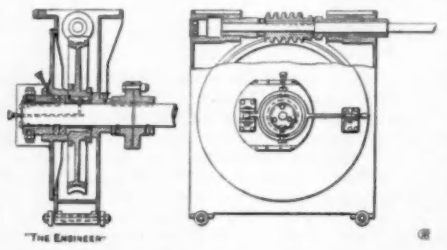


FIG. 22—CLUTCH AND FINAL WORM GEAR OF DRIVE

PROPOSED CHIGNECTO CANAL.

THE Canadian Government recently appointed a Commission to inquire into the feasibility of the Chignecto Ship Canal project, a plan which would result in connecting the waters of the Bay of Fundy with those of the Gulf of St. Lawrence, and thus greatly reduce the navigation distance to Montreal and Quebec from Saint John and other Atlantic seaboard ports of Canada and the United States. The isthmus of Chignecto connects the provinces of New Brunswick and Nova Scotia. A canal would obviate the long voyage around Nova Scotia for ships destined to St. Lawrence ports from Boston, New York, the West Indies, and South America, saving over 300 miles in distance. Forty years ago a ship railway was partly constructed by British capital across the Chignecto isthmus. Ocean vessels were to be hauled over the isthmus by locomotives and deposited in the water on the other side by giant cranes. The feasibility of water passage has also been under consideration many times. The water route has been the object of recent surveys by engineers of the Canadian Government, and the whole scheme, including its economic aspects, is to be gone into now by the Commission appointed to make an exhaustive inquiry. From Cumberland basin on the Bay of Fundy to Baie Verte on the St. Lawrence side of the isthmus would require the digging of not more than about 15 miles of canal—a tremendous project, nevertheless, if of a size to meet fully the demands of the ocean commerce plying the Atlantic from Montreal and Quebec.

Railway and Road Matters.

COMMUNICATION by wireless telephony is now possible from the Southern Railway Company's steamer "Canterbury," which runs on the "Golden Arrow" service.

THE Pullman daily train between Paddington and Torquay and the Pullman cars in the special boat trains of the Great Western between Plymouth and London are to be withdrawn on September 23rd, because, according to *Modern Transport*, they have proved unremunerative.

THOSE old railway officers who had any dealings with the locomotive running department of the London and North-Western Railway during the final ten years of last century and the first ten of this, will regret to hear of the death of that charming and capable personality, Mr. J. O'B. Tandy. Some twenty or so years ago he had a breakdown and took a voyage round the world that did not have the desired effect, so he retired. Mr. Tandy was, without doubt, one of the ablest men in clearing a wreck.

IN appointing, as recorded in our issue of September 5th, an engineer to be the chief stores superintendent, the London, Midland and Scottish Company was but following the example of its neighbour, the London and North-Eastern, which has, in the corresponding position, Mr. A. P. Ross—a son of Sir Alexander Ross—previously the engineer, and then the general manager and engineer to the Cheshire Lines Committee. The appointment of Mr. Ross had, however, been anticipated by Mr. Harold Deans, an assistant to Sir James Inglis, on the Great Western, who was succeeded in 1927 by Mr. A. C. Cookson, who had been steelwork assistant to the Chief Engineer.

THE gross earnings of the Canadian Pacific Railway for July were 14,874,631 dollars, as compared with 19,078,500 dollars for July, 1929, a decrease of 4,203,869 dollars. Working expenses were 11,661,575 dollars, leaving a net profit of 3,213,056 dollars as compared with 3,892,657 dollars, a decrease of 679,600 dollars. For the seven months ending July 31st, the gross earnings were 98,009,606 dollars compared with 120,725,252 dollars for the corresponding months of 1929. Working expenses were 85,390,495 dollars, leaving net profits of 12,618,110 dollars compared with 20,249,488 dollars, a decline of £7,630,277 dollars.

THE financial statement of the Canadian National Railways for the month of July, including the Central Vermont and excluding the eastern lines, shows a gross revenue of 19,150,150 dollars, operating expenses of 16,366,935 dollars, and net revenue 2,283,214 dollars. The figures for the same month of 1929 were gross revenue 24,194,500 dollars, operating expenses 20,345,980 dollars, net revenue 3,848,519 dollars. For the seven months ending July 31st, the aggregate gross revenues amounted to 128,462,138 dollars, as compared with 155,038,319 dollars for the corresponding period of 1929, operating expenses 114,369,710 dollars compared with 129,484,628 dollars, and net revenue 13,592,427 dollars as against 25,554,290 dollars.

AT this time it may be appropriate to remark that the death of Mr. Huskisson—who, by the way, died in the rectory of Eccles—on the opening of the Liverpool and Manchester Railway, is often referred to as the first railway accident. That unfortunate occurrence was not a railway accident in the usual meaning of the term, nor is it likely that Mr. Huskisson was the first person to have been run over on the railway, seeing that the Stockton and Darlington had then been opened for five years. Actually the first fatal passenger train accident occurred two years later, and it was on the Liverpool and Manchester. On November 25th 1832, a passenger train was involved in a collision at Rainhill, and one passenger was killed.

THE current issue of the *Railway Year Book* contains the first public announcement of a change effected about a year ago in the constitution of the Railway Employment (Safety Appliances) Committee. The modification in question is that Mr. J. P. S. Main, the secretary to the Committee, has been made a member, whilst continuing to act as the secretary. The Committee was one of the results of Mr. Lloyd George being made President of the Board of Trade when the Liberal Party came into power in December, 1905, and when the right hon. gentleman found that nothing had been done to comply with the recommendation of the 1899 Royal Commission on Accidents to Railway Servants as to the appointment of a Departmental Committee. Mr. Main was appointed the secretary, and he has remained in office throughout the twenty-four years of the existence of the Committee. The chief inspecting officer of railways is always the Chairman.

WHILST not attempting to deny that it was a serious accident, the daily Press gave a magnitude to the buffer stop collision on No. 1 platform at Euston on the morning of September 1st that the circumstances did not warrant. Buffer stop collisions are the most frequent of passenger train accidents, and there is, on an average, one a week. But that they are rarely sufficiently serious to involve a loss of life is shown by the fact that since the accident of July 27th, 1903, at St. Enoch's Station, Glasgow, not a single passenger has been killed in what may truly be described as a buffer stop collision. The train concerned in the present accident at Euston was the "Night Scot," which was drawn by two engines. The mishap was inquired into, on behalf of the Ministry of Transport, by Colonel Trench on Thursday, the 4th inst., but whilst the newspapers reported the evidence of the guards, platform inspector, and signalman—all of whom suggested an excessive speed—somewhat fully, they paid scant attention to what the incriminated drivers said. We, therefore, propose to await the report by Colonel Trench before commenting on the accident, except that we may say that there was no evidence offered as to defective brakes. Meanwhile, it is only fair to the drivers that we should say that in this column of our issue of August 31st, 1928, we observed: "It is a ticklish job to take a heavy train into a terminal station, especially when, owing to the length of the train, it is necessary to run up to the buffer stops. Particularly is that the case with Euston, as it is approached by a long length of falling gradient of from 1 in 70 to 1 in 112. The entrance into Nos. 1 and 2 platform roads is made yet more difficult by the curvature of the line, which gives a driver a rather short view of the buffer stops."

Notes and Memoranda.

IT is officially estimated that the present output of gold from the Transvaal, which amounts to £43,500,000, will have dwindled to £10,000,000 by 1948.

A PUBLIC light control system, operated by selenium cells, which puts on the lights on the approach of dusk and extinguishes them again on the return of daylight, has been put in operation at Calgary, Canada.

AN air port is being built at St. Paul, Minnesota, by filling in swampy land near the river Mississippi. Incidentally, a bay for hydroplanes is to be provided. The cost of the scheme is working out at about 3500 dollars per acre.

THE annual report of the Electricity Supply Commission of South Africa shows that electric energy is produced at the Witbank power station at a cost of 0·115d. per unit, including interest, redemption, reserve, and administration expenses.

ACCORDING to Mr. S. E. Craig, of the Hydro-electric Power Commission of Ontario, it is good practice when painting new galvanised iron first to wash the surfaces with a solution of copper sulphate. Before painting brickwork, it is advisable to apply a wash of zinc sulphate to neutralise any free lime.

THE researches of the Mazama Committee of Oregon, which has been studying the behaviour of the glaciers of Mount Hope, show that a depth of from 20ft. to 30ft. of ice often melts, or evaporates, from the surface of the ice during one summer season without any corresponding change in actual surface elevation.

A TEST carried out by a Board of Trade Inspector after the explosion of a boiler blow-down pipe at Winsford, showed that this 4in. pipe was subjected to a pressure of 165 lb. when used to blow down a Stirling boiler working at 200 lb. per square inch, although its end was open to the atmosphere. Unfortunately, the report does not give the length of the pipe, although it is stated to have been great.

AN acetylene torch that can cut through an iron hinge from a distance of 25ft. has, it is reported, been tested successfully by the New York Fire Department. The torch, which is equipped with a straight tip burner on a slender iron pole, is intended to aid firemen in cutting through barred windows out of reach of fire escapes and landings. It was designed by a fireman, and it will, it is said, become part of the regular equipment of the New York City Fire Department rescue lorries. In the test, the torch cut through the hinge, 3¼in. wide, in two minutes.

THE ice expert, Dr. Howard T. Barnes, of McGill University, has gone on an expedition sponsored by the Shipping Federation of Canada, which will have as the centre of its operations Notre Dame Bay on the coast of Newfoundland. The main object of the expedition will be to test thoroughly the Barnes-Van-Horne iceberg detector, the principle of which was discovered by Dr. Barnes last summer, and by which it is expected that the exact position of icebergs can be ascertained when they approach within a 6-mile radius of the experimental ship.

RECENT reports indicate a continued rapid development of the hydro-electric power resources of Sweden. The Swedish Government Waterfalls Department in its last annual report, just published, shows a gross income of £1,688,888, and a record net profit of £888,888, corresponding to 5·02 per cent. on the working capital voted by the Government for the past year. The total production of power of the Government hydro-electric plants during 1929 reached the record figure of 1700 million kilowatt-hours, against 1580 millions in 1928. The area of electrified cultivated farms had grown since 1928 from 567,400 to 571,500 hectares, with a corresponding increase of the agricultural consumption of electricity from 34·3 to 38·4 million kilowatt-hours.

THE manhole door of a steam digester in a Yorkshire factory burst, but fortunately no one was injured. In his comments on the mishap the Board of Trade Engineer-Surveyor-in-Chief says: The design of the manhole ring was not a good one and the material used—cast iron—is not a material which can withstand with certainty the process of being riveted for attachment to boilers or similar vessels. Having regard to the process and methods employed, considerable temperature difference between the digester shell and the manhole ring might exist when the plant was being operated. All these factors would tend to bring about the failure of the casting. A reducing valve, by itself, cannot be considered as an absolutely reliable means of preventing the pressure of the supply from the valve rising above that to which the valve is set, and a relief valve to give warning to the attendants or to prevent a rise should be considered as a necessary adjunct to such a valve.

THE process of diverting the Saguenay River at Chute-a-Caron, Que., where a flow of 500,000 cusecs. is concentrated in a comparatively narrow channel about 20 miles below Lake St. John, is described as follows in the *Contract Record*:—Here the Alcoa Power Company are developing a hydro-electric site in two stages. The first stage, comprising the installation of four 65,000 H.P. units, will be in operation early next year. The second state will have a capacity of approximately 1,000,000 H.P. Owing to the velocity of the river the customary means of diverting the flow were found insufficient and something new in hydraulic engineering had to be devised. A dam was built out from both sides of the river, leaving open a deep gorge in the middle. Into this opening there was tipped a precast concrete cofferdam, 92ft. long by 45ft. wide, which had been built in a vertical position on an island in the river and balanced on two piers. This dam contained 5400 cubic yards of concrete and weighed 11,000 tons. The face toward the channel was contoured to fit the river bottom, and when the supporting pier on the side toward the channel was blasted away, the precast dam rolled over a cylindrical part of the remaining pier and fell into place in 30ft. of swiftly moving water, coming to rest within an inch of the calculated position without any fracture. It is noteworthy that a very similar process was adopted by English engineers some twenty years ago in damming the river Tigris.

Miscellanea.

IT is estimated that the proposed bridge across Chesapeake Bay will cost from 10,000,000 dollars to 12,000,000 dollars.

THE completion of the new 500-ton blast-furnace of the Anshan Steel Works, China, raises the pig iron production of the plant to 1100 tons per day.

ANOTHER international toll bridge is to be put across the Rio Grande between Texas and Mexico. It will be near San Benito and is estimated to cost 300,000 dollars.

A RECORD is claimed for the Penallta Colliery of the Powell-Duffryn Company in raising 5532 tons of coal in one shift. The Bargoed pit of the same company recently raised 4020 tons in ten hours.

IT is proposed to provide a new steamer for the Wellington-Lyttelton ferry service, New Zealand, capable of accommodating 1050 passengers. A large number of the cabins will have single berths.

THE new bridge which is being built over the Pearl River at Canton by American engineers is, it is hoped, to be opened in February, 1932. It has a total length of 600ft. with lifting bascule spans of 160ft.

IT is proposed to build in Toronto a twelve-storey garage capable of accommodating 850 cars, on an area of 100ft. by 100ft. The cars will be raised to the upper floors by lifts without attendants, and will be moved to their stalls automatically on belt conveyors.

A COMPLETE survey of the natural resources of the Peace River district of British Columbia is to be carried out by the Canadian Government. The district has already been roughly surveyed by the railway companies, and these surveys are said to have revealed valuable information.

CONTRACTS for the construction of the Abitibi power plant, near Cochrane, Ontario, have been entered into with the Dominion Construction Company, of Montreal. The plant is to develop 275,000 horse-power and will work under a head of 237ft. The storage lake will have an area of 420 square miles.

A NEW bridge, to be constructed over the Clyde at James-street, Glasgow, will cost £116,614 and will give employment to about 200 men for a period of two years or so. Operations are expected to be commenced within a few weeks. The bridge will be constructed of steel girders, rising from concrete cylinders, and will replace the present structure.

A PAMPHLET, entitled "Calcium Molybdate," has been issued by the Climax Molybdenum Company, 295, Madison-avenue, New York, which discusses the preparation of this material used for introducing molybdenum into alloy steels, the method of adding it to the steel bath, the alloy recovery, and how to use it in the various steel melting processes.

A MESSAGE from Cologne states that the Opel Motors Company, which is now in the hands of General Motors, is preparing to place a small car on the German market at the low price of 1490 marks, say, £74 10s. It is suggested that the Opel Company intends to capture the market with this cheap car before the Ford Company's new Cologne works are started next year.

A PUBLIC demonstration in connection with the World Agricultural Tractor Trials, organised by the Royal Agricultural Society of England and the Institute of Research in Agricultural Engineering, University of Oxford, will be held at Ardington, near Wantage, Berks., on September 16th–19th inclusive. Thirty-two machines, representing seven countries, will be taking part and ploughing will commence each day at 10.30 a.m.

AGAIN this winter there will be a course of lectures on "Iron and Steel" by Mr. T. Barton Kelly, at the City of London College, Ropemaker-street, Moorfields, London, E.C. 2. There will be twenty-five lectures, on Tuesday evenings from 6.30 to 7.30, starting on September 23rd. Students resident in London and part of the Home Counties will pay a reduced fee for the course of 25s. 6d. Full particulars can be obtained from the Secretary of the College.

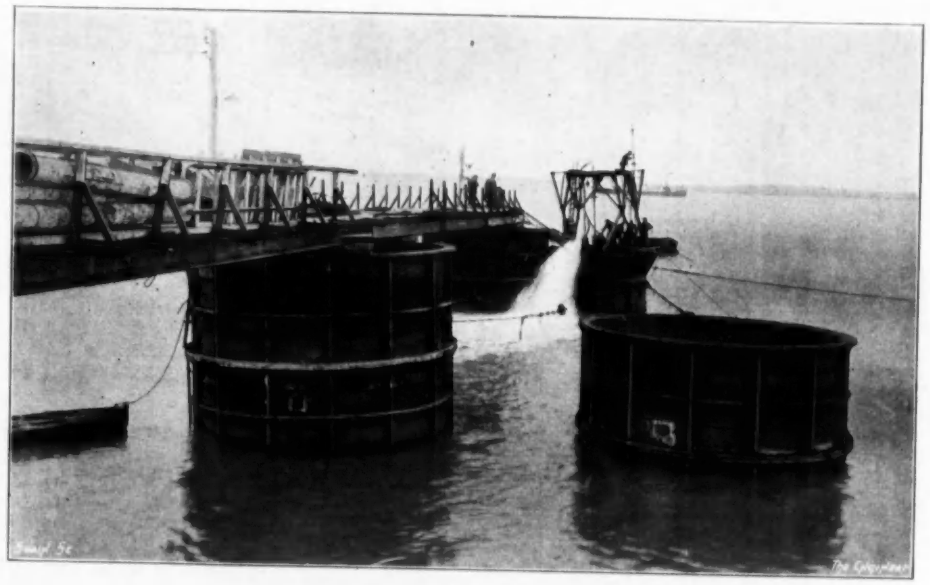
THE annual statistical report of the American Iron and Steel Institute for 1929 contains the usual information for that year in addition to the statistics previously issued in the three bulletins, besides information about the materials consumed by the blast-furnaces. It appears that this consumption averaged per ton of pig iron made 1·750 tons (of 2240 lb.) of ore, briquettes, &c., and 0·178 ton of cinder, scale, &c., or 1·928 tons in all. The rate of consumption of coke and bituminous coal was 2058·6 lb. per 2240 lb. of pig iron and ferro-alloys made in blast-furnaces, the smallest on record.

No other metal has, says the *Ironmonger*, been cheapened in price as quickly and as heavily as berryllium, which is being produced by the Siemens concern and the recently established American-Austrian Berryllium Corporation. In 1923 the price was £2500 per pound, in 1925 £500 per pound, in 1928 £250 per pound, at the end of 1929 £30 per pound, and now it is £22–23 per pound. Further reductions are expected, and it is thought that the price will fall to £8–10 per pound. The production in Germany and Austria was 1¼ tons last year, will be approximately 2 tons this year and will increase further. Berryllium is principally used as an alloy to aluminium, to which it gives unusual strength if added in a quantity of 0·15–0·25 per cent.

THE commercial traffic through the Panama Canal in the fiscal year ended June 30th, 1930, was made up of vessels of twenty-four nationalities. Transits of vessels of United States registry, totalling 2885, exceeded those of any other nationality, with British, German, Norwegian, Japanese, Dutch and Swedish following in the order named. The vessels of these seven nationalities made up 90·5 per cent. of the total transits and 92·3 per cent. of the net tonnage, Panama Canal measurements, and paid 92·2 per cent. of the tolls collected during the fiscal year 1930. The total figures for 1929–30, as compared with 1928–29, are:—Number of vessels, 6185 (6413); tonnage, 37,430,657 (37,464,792) gross tons; tolls, 27,076,890 dollars (27,127,377 dollars).

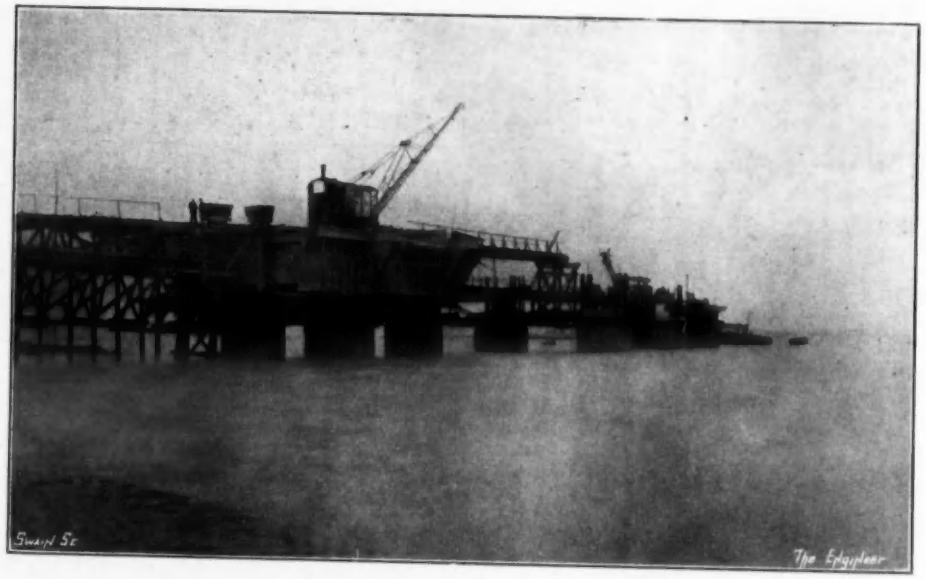
CONSTRUCTING THE VIADUCT LEADING TO THE MOLE AT LE VERDON, BORDEAUX

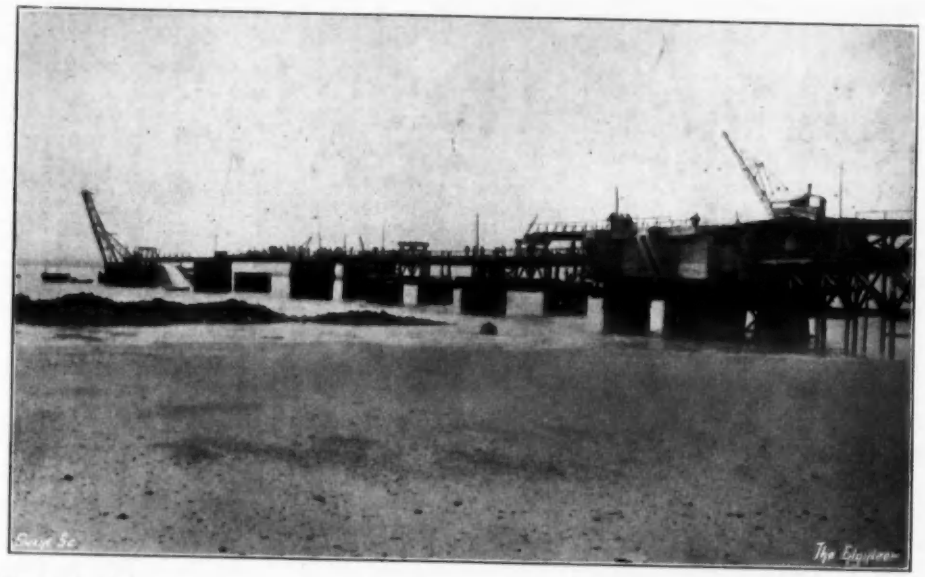
(For description see page 270.)



SINKING ONE OF THE CYLINDERS

SUPERSTRUCTURE ON CYLINDER No. 2





GENERAL VIEWS OF THE VIADUCT, MAY 27TH, 1930

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THE ENGINEER.

VOL. CL. No. 3896

SEPTEMBER 12, 1930.

The Limit to Steam Temperature.

THE decision of one of the Belgian power companies to use steam at a temperature of 470 deg. Cent. or 878 deg. Fah. at the turbine stop valves, and at a pressure of 1500 lb. per square inch, brings home to engineers the enormous advance in steam conditions which has been made of recent years. Nor can the plant to be put down be regarded as of an experimental nature, unless the term is stretched far beyond its usual meaning. An installation starting with two 82,000-kW turbo-generators, together with the necessary boilers and auxiliaries for their operation, is something outside the scale of experiments. It should rather be regarded as the logical outcome of previous developments in power station design, although the courage with which the frontiers of experience are being exploited in all directions at once gives to the new station a noteworthy place in power plant engineering.

The theoretical considerations which urge the use of the highest possible temperatures and pressures are leading to continually greater temerity in practice. So far, fortunately, wisdom appears to be justified of her children. Pioneers like Monsieur Herry as regards temperature and Mr. Moultrop as regards pressure, have borne witness to the attainment of the economies foreseen. Moreover, the experience of these and other engineers tends uniformly to show that plants working under the severest steam conditions of to-day are as free from accident and trouble as those of the most conservative design. All this is very reassuring. It consolidates the ground already won and gives encouragement for further progress. But it also raises the question as to the point at which increases in temperature and pressure will have to stop. One cannot be considered without the other, for, as regards pressure alone, in hydraulic work pressures far higher than steam is likely to be used have been employed for generations, and higher pressures still are certainly feasible. But hydraulic pressures are exercised at ordinary temperatures, where metals have the strength and other properties with which we are familiar. Raise the temperature high enough and the metal will melt, losing all cohesive strength whatever, so that there is certainly some intermediate temperature which must not be exceeded if any desired tensile strength is to be retained. Hence, there is a temperature beyond which it will not be practicable to use steam, and no question is of more interest to central station engineers at the present time than what this temperature is. If it could be settled, for any given metal, by conducting ordinary tensile tests on specimens heated to different degrees, there would be no difficulty about the matter. But such tests give relatively little guidance. Under a load far less than sufficient to cause immediate rupture, a heated steel test piece may stretch for weeks or months. If the load is not too great, the piece will eventually stop stretching and will apparently carry the load indefinitely without further deformation. Otherwise, it will continue to stretch till it breaks. This is about all that anybody really knows concerning the strength of metals like steel at high temperatures. Or perhaps it would be more correct to say that it is all that the majority of investigators have agreed upon. Professor Lea gave a certain precision to the idea by the proposition that for every temperature there is some critical stress, below which the metal will in time cease stretching, and above which stretching will continue until fracture occurs. This critical stress obviously corresponds, from the designer's point of view, with the ultimate breaking stress at ordinary temperatures, for disaster will surely occur if it is exceeded. Following the same line of thought, it would seem possible to decide on a safe working stress at any temperature by finding first the critical stress and by then allowing a sufficient margin for safety. The length of time, however, that certain materials will continue to stretch before one can be sure what they will eventually do, makes the direct determination of critical stress both tedious and difficult. In the laboratory of the Westinghouse Company a piece of ·33 carbon steel loaded with 25,000 lb. per square inch and maintained at a temperature of 400 deg. Cent., was kept under observation for 340 hours, and it stretched continuously the whole time. A copper-manganese alloy at the same temperature was still stretching after a test of 570 hours, although only loaded with 5000 lb. per square inch, or half of its "proportional limit" stress at 400 deg. Cent. Tests of such duration are practically impossible in ordinary manufacturing, and it will, furthermore, be noted that in neither case was the time long enough to determine whether the critical stress of the material had been exceeded or not.

Some more speedy method of finding the critical stress is obviously needed. Professor Lea, observing that after a comparatively short time, the rate of creep for any given stress and temperature appeared to become constant, proposed to plot these constant rates of creep against stress for each temperature. By extrapolating the curves so obtained down to the base line of zero creep, the critical stress for each of the temperatures could be read off. Hence a curve showing the relation between critical stress and temperature could be plotted for any material. The same method has been adopted by continental physicists. It was employed in the elaborate *études* of the pipe work for the power station of Issy-les-Moulineaux, where steam at 625 lb. pressure has to be carried at a temperature of 450 deg. Cent. But how far it is to be relied on is another matter. It depends on the existence of a constant rate of creep, and unless such a phenomenon really exists the method has no logical foundations. At best it would seem doubtful whether the rate of creep can ever be more than approximately constant. All observers agree that the initial rate is comparatively rapid, and tends to become slower. Any subsequent period of constancy must be followed either by a rapidly increasing rate before fracture, or by a rate diminishing to zero. The graph must therefore have curves on both sides of its central portion, so that for any part of this portion to be really a straight line, the law governing the rate of extension would have to change twice during the test. This is improbable. Furthermore, the time required for even approximate straightness to be obtained may be too long for a practical test. A specimen at the National Physical Laboratory took thirty days before the rate of stretch became sensibly uniform, and in another test in the same laboratory constancy of rate was not obtained in a hundred and forty-two days, although by that time the total elongation amounted to 11 per cent. It is evident from these facts that the determination of the critical strength of any material at a series of temperatures may be an

extremely tedious process. Supposing it done, however, all we know is the stress which will ultimately cause fracture at any given temperature. But fracture is not the only thing which may terminate the working life of the metal. A steam pipe, for example, which would stretch 11 per cent. in twenty-two weeks' working would be no use in a power plant, even though it should eventually stop stretching and never burst.

An alternative, and very plausible method of design is based on keeping the working stress below the elastic limit at the working temperature, with the idea that under such conditions no permanent deformation at all could occur. But this presupposes that there is such a thing as an elastic limit at the temperature desired. The formation of slip bands, indicating a minute permanent deformation at very low stresses, suggests that what is known as the elastic limit is something depending on the strain hardening of the material. It is moreover, only strain hardening which can account for the arrest of the stretching of a test piece when the critical stress is not exceeded. If, therefore, the metal is maintained at a temperature above that at which strain hardening is removed, it would seem that it could have neither an elastic limit nor a critical stress. It would, indeed, become permanently ductile. For ordinary mild steel, this condition is probably reached in the neighbourhood of 550 deg. Cent., which sets an upper limit to working temperatures with such metal. The designers of the pipe work at Issy-les-Moulineaux, to which reference has already been made, found in the course of their experiments that the same kind of elastic phenomena which are familiar at ordinary temperatures were to be observed in steel at a temperature of 450 deg. Cent. They therefore determined the elastic limit at that temperature, and fixed their working stresses sufficiently below it to give a reasonable margin of safety. This kind of procedure would seem logical, and we believe it has been followed in other important installations. Yet it may be far from sound in all cases. In the discussion on Mellanby and Kerr's paper on "High-pressure Steam," before the Institution of Mechanical Engineers, Mr. R. W. Bailey quoted an instance in which metal stressed considerably below its elastic limit at 400 deg. Cent. continued to stretch for over two years. Facts such as this are disconcerting, to say the least, for 400 deg. Cent. is now looked on as a very conservative steam temperature. We know, on the other hand, that no permanent change of length has been detected in the pipe work at Langerbrugge, where steam at a temperature of 450 deg. Cent. and a pressure of 800 lb. has been carried for years. It is, indeed, the wonderful absence of troubles due to temperature in stations where the highest steam temperatures are in use that encourages engineers to try still higher temperatures. But there must be a limit imposed by the softening of metal, and it is becoming urgent to establish the true relationship between temperature and permissible stress for all such steels as are used in power plant work.

Dalmuir.

THERE is always something pathetic about the passing of famous works. The mind goes back to the men who have devoted themselves to them, to their aspirations and ambitions, their courage and enterprise, and recalls the successes achieved, the difficulties surmounted and the history made. The works become almost personal and one deplores their loss like that of an old friend or an ancient and well-loved house. The Dalmuir yard is not old in itself and does not belong to an era of shipbuilding and engineering so full of romance as that in which the Maudslays, Penns, Samudas, the Thames, and many another famous yard, both great and small, flourished; but several illustrious vessels were built in it and it played an essential part in the Great War. It enjoyed, too, an international reputation and was an asset of value to the reputation of the kingdom. Like many another famous works, it came to the zenith of its usefulness when the safety of the Empire was in jeopardy, but it is now to be thrown aside as a mere encumbrance. Business has no soul and no pity; that which can no longer serve is wiped out of existence, and nothing remains but a tradition of past services.

When National Shipbuilders Security was established a few months ago it was its avowed intention to rationalise the shipbuilding industry, to get rid of redundant berths, and to concentrate work in a fewer yards under better organisation and less fruitlessly competitive conditions. It was obvious that several yards would have to be closed down, and it was suspected that Dalmuir would be one of them. Two others, one on the West Coast of Scotland and another on the East Coast of England, have also been condemned, and the announcement of their decease will not be long delayed. Wm. Beardmore's yard at Dalmuir was opened just a quarter of a century ago. It was primarily intended for the construction of warships, and H.M. battleship "Agamemnon," of 1906, was the first vessel to be launched; three other battleships, the "Benbow," 1913, "Conqueror," 1911, "Ramilies," 1914, followed; and the cruisers "Gloucester," "Falmouth," "Dublin," "Argus," and "Shropshire," many destroyers, submarines and other vessels for the British Navy were launched there. The last-named of these ships and two submarines constitute the whole of the naval work at Dalmuir since the war, but several notable liners for British and foreign owners have been completed, amongst which may be mentioned the "Conte Rosso," "Conte Verdi," and "Conte Biancamano," for the Lloyd Sabaudo Line. The yard is a very important one, having no less than thirteen berths, the largest 850ft. long. In normal times it gave employment to nearly 3000 men, but during the war that number was doubled; to-day no more than 500 are at work. It is obvious, in these circumstances, that Dalmuir must be fairly regarded as amongst the "redundant" yards, and it therefore falls within the scheme of National Shipbuilders Security, whose avowed object is the dismantling of shipbuilding establishments which are no longer pulling their weight. No more ships will be laid down in it, and as soon as the small amount of work now in hand is completed the yard and its contents will be sold by National Shipbuilders Security, which has now purchased them. The following statement has been issued by the firm:—"This step has been taken in view of the post-war curtailment of warship work and the absence of an adequate volume of the high-class mercantile work for which the yard was suitable, and in order to permit of a concentration of the company's resources on the development of the marine and general engineering works at Dalmuir; at their forge and steel works at Parkhead; and on the other branches elsewhere of the heavy industries in which they still hold a leading position among British firms."

The decline and fall of this once busy place inspires again reflections upon the economical result of the curtailment of one of this country's greatest industries. Great Britain had acquired by sheer merit an unequalled reputation for the construction of vessels of war. Her warship building yards were supported, not only by the ample orders placed by the British Admiralty, but by many from the Governments of other Powers, and constant employment was found, directly, for thousands of men and, indirectly, for many thousands more. A great deal of money was thereby kept in circulation. Only the anti-militarists will believe that anyone was a halfpenny the worse. The money no longer expended upon the British Navy is ostensibly saved for devotion to more useful purposes. But there is no evidence that those purposes are being effected. On the contrary, we see that unemployment has resulted, for useful occupation cannot be found for all the hands displaced and many have to be supported by the State. Since the money for British warship building remained in the country it is difficult to see how the kingdom was poorer by its expenditure on that purpose. Had we been short of labour for other services there might have been a sound argument for naval economy; but as there is always a surplus of labour we lost nothing whatever by employing some of it on constructing and manning ships of war; other work need not have been held back because we were building navies, and money for it would have been more readily found owing partly to the more rapid circulation and partly to the influx which came with foreign orders. Whatever arguments may be used for the reduction of navies, that of national economy has certainly not justified itself. As an economic device it has failed hopelessly in itself and we are deprived of collateral effects which, though difficult to evaluate, were certainly considerable. Developments made in warship building and armament had their repercussion upon the peaceful arts in the domain of merchant shipbuilding, engineering and metallurgy. All that is nearly lost. The dreamer may think that anyone can hammer swords into ploughshares; the practical smith knows that it is not easy and that the quantity of ploughshares that can be produced far outnumbers the demand. Dalmuir goes and others will follow, in part because one of the important industries of the country has been whittled down to nothing, and in part because the circulation of money which that industry caused cannot be diverted quickly in other directions. It is not for us to discuss the political aspects of large navies; but it is ours to record with regret the economic effect of their rapid reduction.

Institute of Metals.

No. I.

THE autumn meeting of the Institute of Metals was held in Southampton from Tuesday last, September 9th till to-day.

At 8 p.m. on Tuesday, the ninth autumn lecture of the Institute was delivered in the Chantry Hall by Professor D. Hanson, Vice-President of the Institute, and Professor of Metallurgy at Birmingham University. The President of the Institute, Dr. Richard Seligman, was in the chair, and there was a crowded attendance, including many non-members of the Institute from the Southampton district.

The President, before calling on Dr. Hanson to give his lecture on "The Use of Non-ferrous Metals in the Aeronautical Industry," said that the autumn lecture of the Institute was not intended to be a highly technical lecture. It was rather designed to interest those in the locality in which the meeting was being held and to indicate in some measure how the work of the Institute bore on their industry or their local activities.

We give the lecture in an abridged form on page 291.

It may be added that this meeting is the first which the Institute has held south of London. The attendance of members and ladies, including some from overseas, was about 200.

(*To be continued.*)

Literature.

SHORT NOTICES.

The Principles of Electric Power Transmission by Alternating Currents. By H. Waddicor. London: Chapman and Hall. Price 21s.—The second edition of this book differs but little from the original edition, published in 1928, only a few minor alterations and additions having been necessary. While the book has been written mainly for students, the practical side of the subject has been kept well in view, and the volume should appeal to designers and engineers responsible for the operation of power transmission systems. The author does not claim to have presented anything novel, but he has brought together a considerable amount of material that has hitherto been recorded in a very scattered literature. Wherever possible fully worked numerical examples have been introduced in order to clarify the subject, but it is not suggested that mathematical methods of solution should be used for all line calculations, as in actual practice charts and nomograms are often used to determine line constants, regulation, &c., and probably furnish results to the degree of accuracy warranted by the state of knowledge of the data of the problem. As the author explains, however, this does not detract from the importance of the more rigorous methods, and there are many problems which cannot be properly solved without their assistance. The book deals with underground cables as well as overhead lines, and considers practically all the electrical problems that confront transmission engineers.

BOOKS RECEIVED.

Physikalische Staubbestimmungen. By O. M. Faber. Halle (Saale): Wilhelm Knapp. Price 3·50 m.

Annales des Travaux Publics de Belgique. 1930. Fasc. 3. Juin. Brussels: Goemaere, 21, Rue de la Limite.

Organisation in the Cotton Trade. By F. Greenhalgh. Manchester: John Heywood, Ltd., Deansgate. Price 1s. 6d. net.

Toward Civilisation. Edited by C. A. Beard. London: Longmans, Green and Co., Ltd., 39, Paternoster-row, E.C. 4. Price 12s. 6d. net.

Wind Stresses in Buildings. By Robins Fleming. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C. 2. Price 17s. 6d. net.

Acoustics of Buildings. Second edition. By F. R. Watson. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C. 2. Price 15s. net.

Chelsea School of Metallurgy: Prospectus for the Session 1930–31. Published by the Chelsea Polytechnic, Manresa-road, Chelsea, London, S.W. 3.

Sir John Cass Technical Institute: Syllabus of Classes for the Session 1930–31. Published by the Institute, Jewry-street, Aldgate, London, E.C.

The Journal of the Institute of Metals, Vol. XLIII. Edited by G. Shaw-Scott, M.Sc. London: The Institute of Metals, 36, Victoria-street, S.W. 1.

The Elements of Ferrous Metallurgy. By J. L. Rosenholtz, Ph.D. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C. 2. Price 15s. net.

Water Supply and Utilisation. By D. M. Baker and H. Conkling. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C. 2. Price 30s. net.

Vectoral Solution of A.C. Circuits. By A. Garnett. London: The Draughtsman Publishing Company, Ltd., 96, St. George's-square, S.W. 1. Price 2s. net.

The British Association.

No. I.

THE meeting of the British Association, which was held in Bristol from September 3rd to 10th, was the fourth to be held in that city. At the first meeting there, in 1836, Lord Northampton, as Vice-president, laid the foundation of the Clifton Suspension Bridge. The attendance this year was well up to the average of what may be regarded as normal years, for the attendance at the Oxford meeting, a few years ago when H.R.H. the Prince of Wales was President, ran into abnormal figures. A general average is between 2000 and 2500, and the number at this year's meeting was about 2300. As usual, the formal opening of the meeting took place on the evening preceding the opening of the Sectional Meetings on the Thursday morning, and a crowded audience listened to Professor F. O. Bower, F.R.S., give his presidential address in the Colston Hall on "Size and Form in Plants." As its title implies, this address was essentially botanical in character, but some general scientific interest attaches to the reference near its close to the prophecy in 1898 by the late Sir William Crookes that by the year 1931 there would be a shortage in the world's supply of wheat unless there was an advance in the production of artificial fertilisers. Professor Bower drew attention to the present large production of wheat by the aid of artificial fertilisers as a striking instance of what scientific research can accomplish.

Of the sectional meetings, our attention, as usual, is mainly centred in Section G (Engineering), which this year had for its President Sir Ernest W. Moir, Bart. It has been the practice for some time now, as the result of complaints made a few years ago, by those who wished to listen to more than one Section presidential address, not to have them all delivered on the same day. Thus the presidential address to Section G was not presented until Friday, September 5th. We reprint it in abstract on page 273.

On Thursday, September 4th, three interesting papers, dealing with various phases of the internal combustion engine were read and discussed together in this section.

TURBULENCE IN PETROL ENGINES.

The first, which was by Messrs. T. F. Hurley and R. Cook, dealt with "The Influence of Turbulence upon Highest Useful Compression Ratio in Petrol Engines." It discussed some experiments which formed part of one of the programmes of research that are being conducted at H.M. Fuel Research Station concerning the influence of vortex and turbulent motions of various types on combustion. In view of the interest which is being devoted to this branch of the subject, the Director of Fuel Research granted permission for the presentation of the paper in advance of a report on the general programme, of which it constitutes a part. The method used in the experiments was to fit various directional vanes to the inlet ports of the engines and to correlate the observations made with the corresponding highest useful compression ratio—H.U.C.R.—of a standard petrol. The work fell naturally into two distinct parts. First, the promotion of various types of turbulence in the charge, and the examination of the movement obtained while motoring the engine; and, secondly, the measurement of the H.U.C.R. resulting from the employment of the types of turbulence observed.

The engine used for the tests was an E 5 Ricardo variable-compression engine, 2¾in. bore by 3¼in. stroke, in which the compression ratio could be altered while the engine was running by moving a piston in the cylinder head nearer to or further from the engine piston. Having a single sleeve valve with two inlet ports, it was particularly suitable for work on turbulence, since arrangements could be made whereby the charge entering either inlet port could be given any desired direction and velocity.

The groups of directional vanes which were inserted in the ports to give the required direction to the air as it entered the cylinder consisted of thin curved parallel plates spaced about $\frac{1}{16}$in. apart. Tests were made with seven different vane arrangements, and, in addition, observations were made when working without vanes, first using two ports, and, secondly, using the right-hand port only, the left-hand port being blanked off.

In the motoring tests, four distinct methods were employed to observe the movement of the air with each arrangement of the directional vanes. They were (*a*) spark experiments with a glass plate in place of the cylinder head; (*b*) spark experiments with a dummy head; (*c*) experiments with the underside of the glass window coated with oil; and (*d*) experiments with water injection, drops of water being introduced into the cylinder with the air. In the spark experiments the engine was motored at various speeds, and sparks from burning material were allowed to enter the cylinder with the intake air, the movement of the sparks being easily observed through the glass plates used. Numerous substances were tried as spark-producing materials, and the best results were obtained with carbonised sawdust. The oil used in method (*c*) was a viscous oil containing small carbon particles and its movement was observed whilst the engine was motored at the normal running speed of 1500 r.p.m.

Observations made by the first two methods, said the authors, appeared to give a strong indication of the movement taking place in the main body of the charge in the cylinder under motoring conditions. It was highly probable that the deductions made from these observations applied to running conditions at least up to the point of ignition. Although the actual velocity of the sparks appeared to be lower at 200 r.p.m. than at 1500 r.p.m., the nature of the movement was quite unchanged. It was, therefore, inferred that the general character of the air movement was not affected by engine speed.

The outstanding feature of the air movement observations which were made under "motoring" conditions, was the difficulty experienced in producing indiscriminate movement as opposed to rotational movement. It was found that there was a strong tendency for the air to swirl about a vertical axis, and, even when a predominating indiscriminate motion was produced, it was accompanied by varying degrees of swirl. It was also found that, with rotational movement, the pressure was least and the linear velocity greatest near the centre, which seemed to indicate that the motion approximated to that of a free vortex. The presence of inward radial flow near the surfaces of the cylinder head and the piston was also demonstrated.

The second part of the paper dealt with the determination of the H.U.C.R. of a standard fuel with various conditions of turbulence. The conditions adopted for the determinations were:—(1) Engine speed, 1500 r.p.m.; (2) mixture strength giving maximum power; (3) optimum spark advance; (4) intake air temperature, 32·2 deg. Cent. (90 deg. Fah.); (5) cooling water outlet temperature, 60 deg. Cent.; (6) air consumption, 29·6 lb. per hour.

The normal air consumption at full throttle, under these conditions of speed and intake air temperature, was 33·8 lb. per hour. This consumption, however, was not obtainable when using directional vanes, owing to restriction of port area. Therefore, all tests were performed at the reduced consumption, the throttle position being varied for that purpose. The corresponding volumetric efficiency was approximately 70 per cent. In order to avoid discrepancies arising through differences in engine conditions, such as variations in carbon deposit, the engine was de-carbonised prior to each test and a check test was made without vanes as soon as possible after each test.

In addition to the tests on the influence upon H.U.C.R. of the port arrangements already referred to, a number of tests were made with reduced port areas, so as to determine the effect of increased air entry speed. Care was taken to restrict the port area in such a way as not to affect the port timing. The fuel used was an ordinary No. 1 petrol. Typical results from a large number of tests were given in the paper, and showed that turbulence had a marked influence on H.U.C.R. Thus, the H.U.C.R. of an ordinary petrol varied from 5·7 to 1 to 7·9 to 1, according to the type of vanes employed, the former value being obtained with indiscriminate turbulence, and the latter with a purely rotational movement. It would appear that, in this connection, the initial direction of the entering air, rather than the initial speed, was the determining factor. Swirling motion was invariably accompanied by very harsh running, particularly at the higher compression ratios, whereas with indiscriminate turbulence the running of the engine was exceptionally smooth.

With regard to power output, the authors stated that, although the primary object of the experiments was to determine the influence of turbulence upon H.U.C.R., brake readings were taken incidentally. At the same compression ratio, with uni-directional swirl, the power output was some 4 per cent. less than with indiscriminate turbulence. Furthermore, it was noted that, with uni-directional swirl, the rate of increase of power output with increase of compression ratio was somewhat less than with indiscriminate turbulence. The observations made did not provide sufficient data to justify conclusions as to the cause of this loss of power with swirling turbulence, but the authors suggested the probability that at least part of the loss was due to increased frictional losses.

Discussing the results as a whole, the authors said that, insamuch as the tests comprised only the first section of a programme dealing with turbulence, any comprehensive attempt to bring them into line with the many theories and published data regarding engine detonation would be premature. Nevertheless, they put forward an explanation of the observed facts as a matter of interest, even though it might be revised in the light of subsequent experiments. It was known, it was pointed out, that the velocity of flame propagation in a stagnant mixture was so low that the mixture could not be burned in the time available for its combustion in an engine. Reliance must, therefore, be placed upon turbulent motion between the burned and unburned portions of the mixture to speed up combustion and spread inflammation rapidly throughout the charge. As with pure rotation there was no radial movement, it might be expected that the time taken for combustion with swirling turbulence would be long. Actually, it was found that the optimum spark advance at a given compression ratio with indiscriminate turbulence was, generally speaking, larger than that necessary with rotational turbulence. A possible explanation was that, with rotational turbulence, the earlier stages of combustion took place more rapidly than with indiscriminate turbulence, and that the reverse was the case in the later stages, *i.e.*, when the flame, firmly established, spread throughout the main body of the charge.

After discussing the process of combustion with rotational turbulence and with indiscriminate turbulence the authors suggested that their theory afforded an explanation of most of the observed phenomena, including that in connection with spark advance. The rapid and essentially local combustion in the neighbourhood of the sparking plug with rotational turbulence, explained the quick initial pressure rise causing "combustion knock" and overheating of the sparking plug. It could also be made to reconcile the experimental results with various theories of engine detonation. If, for example, pinking was considered to be due to auto-ignition of the unburned portion of the charge when compressed beyond its self-ignition temperature by the expansion of the burning portion, an explanation of the difference in H.U.C.R. obtained with swirling and indiscriminate turbulence was easily made. With the former the rate of flame propagation during the later stages of combustion would be too low to establish the necessary conditions for the spontaneous ignition of the unburned charge, and, moreover the length of flame travel from the central core would be small, whereas, with the latter, the rapid movement of the flame would favour the attainment of a critical temperature and pressure by any gas trapped in a pocket.

If that theory were correct, the authors concluded, it should give rise to a new tendency in combustion chamber design, viz., the arrangement of the cylinder in such a way that part of the mixture would be maintained near the sparking plug, either stagnant or in a state of indiscriminate turbulence, thus ensuring the absence of "combustion knock," whilst the main body of the charge would be given a definite uni-directional swirl, thus enabling a high compression ratio to be used without detonation.

AIR-COOLED AERO-ENGINES.

Mr. C. F. Abell, of the Bristol Aeroplane Company, Ltd., presented the second paper, in which he discussed some recent progress in air-cooled aero-engine development. In the first place, he mentioned the more important factors which guide or circumscribe development, in order that his hearers might the better understand the reasons for methods, &c., which, in other branches of engineering, might be considered absurdly impractical. The most important of those factors was the weight per horse-power; other factors, the importance of which varied according to the type of service for which the engine was intended, being fuel and oil consumption, low resistance to passage through the air, maintenance of power output under conditions of reduced atmospheric density at altitude, and, as a *sine qua non*, reliability.

The paper covered the period of the past ten years, because that period had seen the beginning of the modern air-cooled aero-engine as we know it to-day. Ten years ago the water-cooled aero-engine was supreme in all fields; there was then no air-worthy air-cooled engine of moderate or high power in existence throughout the world, the original type—the rotary—having failed, through inherent limitations, to keep pace with the developments in power output, economy and reliability brought about under the stimulus of the war. Although, at that time, air cooling for aero-engines appeared obsolete, a great deal of research was progressing, and the outcome of it was the appearance of the Bristol "Jupiter" nine-cylinder air-cooled radial, developing 380 B.H.P. for a complete weight of 750 lb. In 1921 this engine completed the British Air Ministry's type test, and it was the first air-cooled aero-engine of this type in the world to pass an official test of that nature. The completion of the test was undoubtedly a landmark in the history of air cooling, and a turning point in the fortune of the air-cooled aero-engine. Since that date, much progress had been made, and now the air-cooled engine was almost universally employed for private and commercial machines and for a big proportion of military machines also.

Summarising the progress made during the ten years, the author pointed out that the weight per horse-power had been reduced by 25 per cent., the power output increased by 50 per cent., and the period between overhauls increased by 700 per cent., with a corresponding increase in the reliability of the engine and the life of the main components. There were now engines of 500 H.P., weighing 750 lb., with fuel consumptions of 0·5 lb. per horse-power hour, covering approximately 50,000 miles between overhauls and costing approximately £3 per horse-power, which compared favourably with other prime movers.

Some of the recent changes in design which had led to higher speeds of revolution, higher B.M.E.P., and higher overall efficiency in the "Jupiter" radial engine were then discussed. One of those changes was the development of a split single-throw crank shaft to take the place of the normal solid crank shaft.

The original form of split rod and solid crank involved considerable skill and accuracy in machining, and concentration of stress at the four big end securing bolts was unavoidable. The construction of the solid rod and split crank shaft, on the other hand, allowed of the solid connecting-rod and plain circular floating bush being readily assembled on the crank pin, after which the rear half of the crank shaft was bolted up, all risk of concentration of stress in the big end of the connecting-rod being abolished by that construction. Whereas with the original form of split rod and solid crank rotational speeds were limited to 1500 to 1600 r.p.m., the present engines, employing the solid rod and split crank shaft, rotated normally at 2000 r.p.m., with a maximum of 2200 r.p.m.

Concurrently with the crank shaft and connecting-rod development, the manufacturing problems in connection with crank cases were considered, and castings were abolished in favour of drop forgings for the "Jupiter." The particular form of case employed in that engine, and the fact that foundry cracks in some cases developed in castings after only a few hours of service were factors which led to the adoption of drop forged light alloys. Such forgings were symmetrical pieces, and offered no special difficulty from the point of view of the drop forger. Considerable criticism had been levelled against the adoption of that form of crank case, on the score of manufacturing costs on a production basis, especially in view of the fact that both halves of the crank case had to be machined all over, but the actual cost of producing a batch of, say, fifty complete engines with the forged crank case instead of a casting was definitely lower, owing to the complete elimination of crank case scrap. Such scrap might be due to the disclosure of a casting flaw by the turning tool or milling cutter after the greater part of the machining operations of the component were completed, and in some cases casting stresses caused cracks to develop while an engine was undergoing its final test before despatch. Actual machining of the forged crank case offered no special difficulty. A certain amount of special jigs and fixtures had been designed to deal with the problems encountered, and no difficulties were experienced in the shops in the production of a relatively complex and highly stressed component. The weight of the complete crank case as forged was 200 lb., but the weight as machined and finished was only 73 lb.

Developments had also been effected in cylinder design, from the solid steel cylinder with integral combustion head, to a cylinder employing a loose head, formed by a light alloy forging. The former was employed for many years with complete success, but in view of demands for higher efficiency, and the development in combustion chamber technique, the new cylinder was evolved. The latter consisted of an open-ended steel barrel fitted with a head of light alloy screwed in position. The combustion chamber was no longer formed by the integral steel end of the barrel, but by the light alloy head itself, which head carried the valve seating, valve guides, and bosses for spark plugs, &c. At first a casting in "Y" alloy was used for the head, but the same difficulties applied to those castings as to the crank case castings already referred to, and light alloy drop forgings were substituted. The intricate machining operations on the cylinder head presented some difficulties in the first place, but with the aid of special tools and equipment, the heads could be produced entirely satisfactorily. A good deal of care had to be devoted to the development of the new cylinder, but the difficulties were overcome, and the present design allowed the maintenance of a B.M.E.P. 10 per cent. higher than formerly, a speed 15 per cent. higher, and a reduction in fuel consumption of 10 per cent.

The new design of cylinder permitted the employment of a considerable degree of supercharging to enable the ground level horse-power to be maintained up to considerable altitudes—the present design being intended for 12,500ft. The supercharger consisted of a centrifugal fan driven by a simple form of gearing enclosed in the back of the engine.

Discussing the various types of air-cooled engines, Mr. Abell said that the success of air cooling had been built up on the radial type, but that attempts had been made to evolve other types, which either developed certain advantages of the radial or obviated some of its disadvantages. So far, however the only types in quantity production were the radial for all sizes up to 700 H.P., and the small in-line engine in sizes below 200 H.P., where, owing to the importance of price, the specific weight ratio could be raised. For the higher powers, work was in progress upon the hexagon, the Vee and the "H" types of air-cooled engine.

The radial type of engine, he continued, had been thoroughly tested in a very large variety of sizes. It offered many advantages from the manufacturing point of view, owing to the components being in a large measure symmetrical, and in easily handled sizes, and made from comparatively easily obtained raw materials. Owing to the simplicity of the components, a large number were readily obtained in the form of drop stampings, which allowed of the deletion of castings for all but the minor unstressed parts. As regarded installation in the aircraft, a most simple form of engine mounting ring was possible. Engines could be changed very readily when overhaul was needed, and the work involved in the dismantling and reinstallation was reduced to a minimum.

The in-line type was available up to the present only in low powers. It was thought that the development of that type was limited for high powers, by the difficulties of cooling cylinders of large size.

The Vee type obviously represented an intermediate stage between the first two types, with a corresponding balance of advantages and disadvantages; such engines were available in medium powers, but were not in extensive use.

The hexagon and "H" types still nearer approached to the radial form, the former being a current production type in America, and the latter being still in the experimental stage, but results appeared to be very promising. Both types seemed particularly attractive for the higher power outputs, provided the rear cylinders could be suitably cooled.

Examination of these alternative types showed that the outstanding feature was the attempt to cut down the frontal area, and therefore the drag, which, in the opinion of the critics of the radial type of engine, was its big disadvantage. That contention had undoubtedly considerable justification for speeds of from 150 to 200 m.p.h. or more, such as were now being obtained in certain classes of machines.

Commenting on the view which had been expressed that the drag of the radial engine must necessarily restrict the employment of that type of motor to the slower machines—in which drag, which follows the square of the speed law, is of lessened relative importance—Mr. Abell said that two recent developments, one of British and one of American origin, had reduced considerably the drag of the air-cooled radial, so that it satisfied the requirements of all type of machines, except that in which everything had to be sacrificed or compromised for speed. For that latter highly specialised field the water-cooled engine was so far the most suitable. One of the two developments referred to was the Townend ring, which originated at the National Physical Laboratory. By that device an attempt was made to smooth out the air flow—which had been disturbed by the projecting cylinders of the engine—immediately it had passed the cylinders and had performed its useful work of cooling them, and thus avoid interference drag caused by the turbulent flow. That was effected by confining the air flow circumferentially within a ring of aerofoil section coaxial with and surrounding the engine. The exact position of the ring and its dimensions varied with the engine, type of installation, and operating conditions. The second development to which Mr. Abell referred was that of a cowling completely enclosing the engine. The cowling was of stream-line form itself, and in relation to the fuselage, and it owed its success and practical application to the American National Advisory Committee of Aeronautics. There was an opening at the front, the size of which was adjusted to permit the entry of the amount of air required for cooling the engine. To ensure the maximum cooling effect from a given quantity of air, the air was guided around and over the cylinders by an internal cowling covering the lower portion of the cylinders, in a similar manner to the conventional cowling, and, finally, allowed to pass out through a circumferential gap to join, with the minimum of disturbance, the larger portion of air stream which had travelled smoothly over the external cowling skin, and continue in a similar manner over the fuselage.

The improvement due to these developments, he said, was of approximately the same order, amounting, for example, in the case of a single-engined machine, to a reduction in drag of from 15 to 20 per cent., equivalent to a corresponding saving in the power output required from the engine for a similar performance with a conventional cowling.

THE HIGH-SPEED HEAVY-OIL ENGINE.

The third and final paper was by Dr. S. J. Davies and Mr. E. Giffen, and it discussed "The Present Position of the High-speed Heavy Oil Engine." The authors reviewed the present position of engines in which the fuel is injected in liquid form into the combustion space, and with speeds of revolution exceeding 800 r.p.m. They pointed out that in Great Britain, in particular, the past two years had witnessed extraordinary activity in that direction, although the country had started a good deal later than continental countries. Engines of the type under consideration now competed directly with the petrol engine. Since it was possible, in the heavy oil engine, to employ a higher ratio of expansion than in the petrol engine, higher thermal efficiencies were to be obtained. Further, heavy oils cost, under present market conditions, about 4d. per gallon, and comparative tests of petrol and heavy oil engines showed a saving in fuel cost with the latter of some 70 per cent. Heavy oil, too, occupied some 16 per cent. less volume than an equal weight of petrol, which was an additional consideration when radius of action was important.

The foregoing were the general points put forward in the paper in favour of the high-speed heavy oil engine. In addition, mention was made of the greater degree of safety from the point of view of fire and the comparative purity of the exhaust gases. Figures of tests were given showing a comparative absence of CO in the exhaust gases, an important matter when engines were run in confined spaces and in towns.

As regards mean effective pressures, maximum pressures and weights per horse-power, it was admitted, the authors agreed, that with present practice the advantage lay with the petrol engine. Those were factors of great importance in aircraft, but it was suggested that in other cases, in which weight was not so important, the advantage of the petrol engine was, in practice, much less marked. Although in Germany there were some 200 lorries running with heavy oil engines, no conclusive data of maintenance charges were available to compare with those of petrol engines, but the reduction in the fouling of the crank case lubricating oil and the elimination of the ignition gear led the authors to suggest that the maintenance charges with heavy oil engines should, at any rate, not be greater than with petrol engines. Under present conditions of output, initial costs were much greater than in the case of petrol engines, but given equal volumes of production the difference in capital cost should only be slight.

The superiority of the heavy engine oil in thermal efficiency was well known, but a point not fully recognised was the superiority of the fuel consumption of the heavy oil engine at reduced loads, and the fact that combustion was affected to a smaller degree by speed of revolution than it was with the petrol engine.

The paper then discussed the development that has taken place in the methods in which the fuel is brought into contact with the air supplied for combustion. They are (*a*) direct injection of the fuel into a simple combustion chamber; (*b*) injection of the fuel into an ante-chamber in which the combustion begins, the consequent rise of pressure there causing the fuel to be forced into the main combustion chamber where combustion is completed; and (*c*) compression of the air into a cavity in the combustion chamber either in the piston or cylinder head, injection of the fuel being arranged to take place into the air escaping from the cavity at high velocity at the beginning of the expansion stroke. Diagrams were shown of the shapes of the many engines of the type under discussion now being made—some twenty-eight in all—and the three methods referred to above were discussed in detail and comparisons were made between them from the points of view of performance, mechanism of combustion, and the necessary accessories.

The first impression from a study of the information presented in the paper is the extraordinary variety in the types of engines in which the problems mentioned have been satisfactorily solved, by firms in Great Britain, America and on the Continent. The information given indicates that combustion chambers with direct injection yield the best thermal efficiencies, allow of starting from cold without auxiliary help and are the least complicated in design. They have the disadvantage, however, that in order to obtain the necessary fine division of the fuel, the pressures in the fuel system are usually very high and that the maximum working pressures in the cylinders are also high as compared with that in the other two types.

The general features of the fuel pumps and fuel nozzles in use on the various engines were also reviewed, and special reference was made to a type of engine which cannot be placed in the category of the compression ignition engine, although it must be classified as a high-speed heavy-oil engine. It is the Hesselman engine. By incorporating the ignition arrangement of a petrol engine in this design, it is possible, while retaining the advantage of the heavy oils, to avoid the high compression and maximum pressures usual in the compression ignition heavy-oil engines. This is done in the following manner. The induction air is given a swirl about the axis of the cylinder by shrouding the inlet valves, and the injection of the fuel in a fine spray is so timed that it passes before the sparking plug at the instant of sparking, and is thus ignited. The design is being applied to commercial lorries in this country by Leyland Motors.

In comparing the three groups of makers—British, Continental and American—there are certain outstanding points to be noted. Only one firm in this country, Messrs. Petters, of Yeovil, is working on a two-stroke design. Only one firm on the Continent, viz., the Junkers Company, of Dessau, produces two-stroke engines—working on the opposed piston principle—while in France there is one two-stroke engine. In America, on the contrary, considerable attention is being given to this type. Further, the small amount of support from British firms for the ante-chamber type of engine is remarkable.

The paper concluded with a congratulatory reference to the progress made by British engine builders in this field in the past two years, a particularly welcome circumstance when their late start is considered.

In the list of British makers are mentioned the A.E.C., Beardmore, Blackstone, Brotherhood (Ricardo), English Electric, Gleniffer, Lister, McLaren-Benz, Mirrlees, Bickerton and Day (Ricardo), Petters and the R.A.E., Experimental (Taylor). In addition, other firms working in the same field in this country are Ruston and Hornsby, the Sunbeam Motor Car Company and Gardner.

DISCUSSION.

The President of the Section, referring to the dangers of emission of CO from the exhaust of engines using petrol and heavy oil for road transport purposes, said that he would like to see a greater use made of producer gas plants on transport vehicles, using coal.

Although we exported coal to the value of £54,000,000 annually, we imported oil to a greater value.

Commander Cave-Brown-Cave said that his own recent personal experience had been with the compression ignition engines on the R 101, the main engines of which developed 600 H.P. each at 900 r.p.m. with a B.M.E.P. of 100 lb. The consumption of fuel was slightly below 0·4 lb. per H.P. hour at full power, while at cruising speed it was very comfortably below that figure. One difficulty encountered with these engines was the choking of the spray, and that was partly overcome by filtering the fuel before it went through the atomiser. A complete cure was effected eventually by placing a minute filter actually in the nose of the atomiser. Another trouble was the dilution of the lubricating oil by the fuel oil. A further point to be borne in mind in comparing various types of compression ignition engines was the method of starting. That was always a trouble. In the case of R 101, small auxiliary engines were used to turn the main engines up to a speed of about 120 r.p.m., and then the main engines started satisfactorily. He believed that the future development of the compression ignition engine lay in an increase of speed, and he did not think the difficulties in the way of increasing the speed of the compression ignition engines would be found to be very serious. That had been made apparent from the work of Ricardo on increasing the speed of such engines. At the same time, there were certain points to be avoided. For instance, if the atomiser valve had any moving parts, there was likely to be trouble because of their inertia. In the case of the Beardmore engine, the needle valve spindle was of some weight, and he did not think it would be found satisfactory if the speed were increased. The principal difficulty would be in increasing the speed of burning. Ricardo had shown that there was an initial hang-fire, then a comparatively slow start and propagation of the flame, and then a steady burning as the fuel was continuously admitted. But the initial hang-fire was the trouble, and the only way to overcome that difficulty was to increase the temperature of the air with which the fuel was injected. For that purpose it would be desirable to increase the maximum compression pressure and possibly also to pre-heat the air. As regarded the paper by Mr. Abell, he recommended all engineers interested to visit the Bristol Aeroplane Company's works and see for themselves the marvellous accuracy with which air-cooled aeroplane engines were being produced, not as isolated special jobs, but on mass production lines. Those engines ran for 50,000 miles between overhauls with an extraordinary degree of reliability.

Mr. D. R. Pye (Air Ministry), criticising some of the circumstances of the experiments described in the paper by Messrs. Hurley and Cook, suggested that the position of the spark would affect the results. In the present case, the spark was at the centre of the cylinder and a difference in the swirling motion, which was concentrated round the periphery of the cylinder, would not greatly alter the effectiveness of the spark in producing rapidity of burning because the distribution of the flame from the centre would not be altered very much as the peripheral speed was accelerated. If the spark had been placed excentrically in the head of the cylinder, he would imagine that a very much reduced spark advance would have been found necessary at the highest swirl conditions, with a reduction in time of combustion. At the same time, Ricardo showed, a few years ago, that it was possible to get so much swirl that, so to speak, it blew out the spark and made it impossible to get any ignition at all. It was also necessary to measure the fuel consumption and thermal efficiency under varying conditions of swirl, because the heat loss due to increased swirl, and, consequently, reduced thermal efficiency, was important. It was also very important to know what the fuel mixture was when speaking of detonation. The authors stated that their engine was adjusted for maximum conditions, but those might vary between fairly wide limits, and that would make a difference in the temperatures of the working substance on account of the latent heat of evaporation of the fuel, which, when the mixture got too rich, cooled down the gases in the cylinders. After supporting what Commander Cave-Brown-Cave had said with regard to the Bristol works, Mr. Pye referred to the compression ignition engine and mentioned the paper recently read before the Diesel Engine Users Association by Mr. Ricardo, in which he showed that with his single-cylinder engine with a B.M.E.P. between 70 and 95, he was able to maintain a fuel consumption of 0·35 lb. per B.H.P. hour, which was below what was given as the best in the paper by Dr. Davies. That was a long range over which to maintain such a low fuel consumption. The consumption was experienced with an engine with a cylinder 5½in. by 7in., running at 1300 r.p.m., but on another engine running at 2200 r.p.m., *i.e.*, with a piston speed of 2570ft. per minute, Ricardo obtained a fuel consumption on an indicated horse-power basis equally good as that at the lower speed and with an equally good thermal efficiency. There was, therefore, no reason to suppose that speed was a limitation with the heavy-oil engine, any more than it was with a petrol engine.

Prof. W. Morgan said that the paper by Messrs. Hurley and Cook gave him information which he had been seeking in connection with work he had been doing in Bristol. In setting up the swirl, however, he noticed that no attention had been paid to the possible effect of the exhaust port arrangement, which, as a matter of fact, previous experiments had shown to be considerable, and the exhaust port arrangements should be watched in connection with investigations on swirl. The shape of the combustion chamber could also exercise considerable influence on the results, and the authors had used only one shape of combustion chamber. Therefore, the results given in the paper could only be taken as applying to that one particular shape, although the general conclusion with regard to indeterminate turbulent flow, as compared with steady flow, would remain true for any type of cylinder. Speaking of the compression ignition engine, Professor Morgan expressed the view that the future lay with the two-stroke engine. Reverting to the paper by Messrs. Hurley and Cook, he suggested that the term H.U.C.R. —highest useful compression ratio—was illusory generally, and that in the present case it had been obtained under very unreal conditions. Under practical conditions nobody would think of using a mixture giving maximum power except for racing purposes. For ordinary purposes we took some optimum condition which gave a high degree of power with a high degree of economy. In the same way a volumetric efficiency of 70 per cent. with a piston speed of 1000ft. would not be tolerated under practical working conditions. Any public omnibus would be expected to have an efficiency of 85 per cent. at that speed, and would hardly be allowed on the streets otherwise. In all these circumstances, therefore, the term "useful" was misleading, and it would be better to have some method of determining the highest ratio that could be used to give perfectly smooth running, although even that might be misleading, as smoothness of running was dependent on so many factors besides compression ratio. An important feature in connection with compression ignition engines was the deodorising of the fuel, because the heavy oil used was bound to creep, and it gave off an unpleasant odour, and everything should be done to prevent that.

Dr. J. S. Owens said that the percentage of CO in a petrol engine exhaust was 3 per cent., whereas with a heavy-oil engine it was only 0·19 per cent., and that was of considerable importance having regard to the large number of vehicles in large cities and the conditions likely to arise in traffic blocks.

The President also commented on the dangerous effects of even small concentrations of CO in the atmosphere.

Mr. Hurley, replying to the discussion, said that, as regarded spark advance, mentioned by Mr. Pye, the point made in the paper was that the spark advance at the same compression ratio was practically constant for rotational swirl and for indiscriminate turbulence. As to placing the spark excentrically to get a shorter time of combustion, that result was actually obtained in the experiments described in the paper. Speaking generally, the experiments tended to confirm the theory the authors had formed with regard to the spark advance at the time of combustion.

Mr. Cook, replying to Professor Morgan's criticisms of the first paper, said that no attempt had been made to consider the effect of the exhaust port arrangement as it was felt that the induction port arrangement had the greatest effect, but experiments on the exhaust port arrangement would be carried out. He agreed that the term H.U.C.R. might be misleading, but it was one which was often used, and he believed that increased compression ratio was the direction in which to look for increased efficiency.

Dr. Davies also briefly replied.

(To be continued.)

Obituary.

RICHARD MUIRHEAD.

By Colonel R. E. CROMPTON, R.E.

RICHARD MUIRHEAD was born in 1844. He was articled, when sixteen years old, to the late Edward Hayes, of the Watling Works, Stony Stratford, and, when there, was employed on the construction of the steam carriage then being built by Thomas Rickett, of the Castle Foundry, Buckingham.

After completing his time with Hayes he went to the railway workshop of the London and North-Western Railway at Wolverton, and later on to Messrs. John Penn and Sons, at Greenwich. Whilst at Penn's he met with a very severe accident. His head was caught between a connecting-rod head and the crank of a paddle wheel engine, which was being revolved by hand. His neck was so nearly dislocated that his life was despaired of, but he was saved by the extraordinary skill of one of the leading surgeons of his time, who took a special interest in his case.

After recovery he became engineering instructor and demonstrator of locomotives at the Farnah Hall Training College of Engineers, near Derby. When there he persuaded Montford, the head of the College, to build a steam carriage, and succeeded in conveying passengers at a fair speed on the loose gravelled private roads in Farnah Park.

In 1871, hearing of what I was doing with Thomson road steamers, specially designed for road transport work in India, Muirhead wrote me and asked to be allowed to bring Montford and some of his pupils to see the road train named the "Ravee," which was then on a trial trip from Ipswich to Edinburgh. Muirhead then showed such knowledge and keenness for this special work that I applied for his services to act as my assistant in India, with the title of Assistant Superintendent Indian Government Steam Train. In India, during the five years that followed, Muirhead showed great inventive power, especially in adapting the large rubber tires which were then used, so as to avoid wear and tear on their inner surfaces, and, further, was responsible for many modifications of the armouring which we then found it necessary to use to reduce the wear on the outer surfaces of the tires. On the termination of the India experimental work, which was brought to an end by the India Government then believing that narrow-gauge railways laid alongside the Grand Trunk and other roads would supersede any direct form of road transport, Muirhead was pensioned off and returned to England.

He lived to a ripe old age, always retaining his strong interest in road transport development, and he saw many of his ideas carried out in practice.

He died on July 31st, 1930, aged eighty-six years.

SIXTY YEARS AGO.

"IT is possible," wrote our correspondent in Paris in our issue of September 16th, 1870, "that this may be the last letter I may be able to send you for a time, for it is said that all available forces of Germany are coming on towards Paris, and that the orders from headquarters are that seven *corps d'armée* are to be in their places around Paris on the 14th inst." He was correct in his surmise. His next letter, dated October 1st, appeared in our issue of October 14th, and was sent from Paris by balloon post. The siege began on September 19th, and was continued until January 30th, 1871. We had, however, other matters besides the Franco-Prussian War to engage our attention. At the moment of going to press with our previous issue we had doubtlessly just received the staggering news that H.M.S. "Captain" had been lost with almost all her 500 hands. During the ensuing week confirmation and details of the disaster were received. We described it in our issue of September 16th as an event almost without parallel during the last hundred years save that supplied by the sinking of the "Royal George" at Spithead. At 12.15 a.m. on the 7th the "Captain" was off Finisterre under double-reefed fore and main topsails, close hauled on the port tack. The wind, about north-west, was very squally, with rain and a heavy sea. The ship was felt to make a very heavy roll to starboard, and before she had time to recover a sea struck her, throwing her on her beam ends. She turned bottom upwards and 10 minutes later sank stern first. Mr. May, the gunner, and seventeen men, the sole survivors, landed in a launch at Finisterre about twelve hours later. Thus perished the commander of the ship, Captain H. T. Burgoyne, V.C., the only son of Sir John Burgoyne, an eminent engineer; with him were lost the designer of the ship, Captain Cowper Coles; a son of Mr. Childers, the First Lord of the Admiralty; and about 480 officers and men. The history of the ship is well known. As we recorded in this note a few weeks ago, she was built by Laird Brothers at Birkenhead to the general designs of Captain Coles. She was a low freeboard turret ship. Her construction, so it is to be supposed, was forced on the Admiralty by popular demand expressed in Parliament and the Press. An error was, however, made in her design as a result of which she went to sea with a freeboard of not much more than 6ft. instead of 8ft. as originally intended. The cause of the disaster was popularly held to be attributable to the vessel's low freeboard. It is, however, certain that in addition she was deficient in stability, particularly in view of the area of sail with which she was provided as a means of propulsion, additional to her engines. It was apparently known at the Admiralty before the vessel put to sea on her last trip that her righting moment reached its maximum value at a very low angle of heel, namely, at about 21 deg. Following its rule of never imparting to commanding officers information concerning the characteristics of their ships, the Admiralty, it seems, had left Captain Burgoyne in ignorance of the fact that the vessel of which he was in charge was in any way exceptional as regarded stability. The disaster for a time retarded the development of the turret type of warship, but it was eventually realised that, good as she had shown herself to be in her short existence, the "Captain" was a very imperfective representative of the best form of turret ship.

IN the course of an investigation of the particle size of lime, it was desired, by the American Bureau of Standards, to study the rate of settle of lime from a suspension in a liquid. To do this an automatic weighing device was set up. On one arm of a precision balance was suspended a small permanent magnet which hung down into a solenoid. On the other arm was hung a pan upon which the lime settled. The balance was then kept in equilibrium by controlling the current flowing through the solenoid. A mirror mounted on the balance beam controlled a photo-electric circuit, which, through a relay and motor, controlled the sliding contact in a rheostat in series with the solenoid. The resistance was thus maintained at such a figure that the balance remained in equilibrium all the time. A record of the current flowing through the solenoid could be changed into a weight time record, which was necessary to calculate the particle size distribution of the lime. To check up on the performance of the balance, successive milligram weights were recorded through the electrical system as $1 \cdot 01 \pm 0 \cdot 1$ milligram.

Opposed-Piston Heavy-Oil Engines.

No. II. (*Conclusion*).*

CONTINUING our article on the opposed-piston oil engine, we append the following report of some tests carried out by Dr. S. J. Davies, Ph.D. (Eng.), M.Sc., M.I. Mech. E., of King's College, London :—

REPORT OF TESTS.

At the request of the Junkers-Werke I visited the works at Dessau, Germany, on July 7th, 1930, and carried out a series of tests on the engines. The principal object of the tests was to investigate the preformance of the engines over wide ranges of speed and load. Tests were made, in addition, of the accuracy and sensitiveness of the governing, and also of the volumetric or charging efficiency of the scavenging pumps.

The type of engine submitted for test was the "2 HK 80," and, for reasons to be stated, two such engines—Nos. 7006 and 7031—were tested. The engines were taken from the ordinary batches under manufacture, No. 7006 from one series and No. 7031 from a different series. These are lorry engines, and, although the test results can indicate their suitability for transport and similar purposes, they were actually selected from the types of single-crankshaft engines of Junkers design—which range from engines of 60 mm.—2·38in.—bore, running at 1200 r.p.m., to engines of 400 mm.—15·74in.—bore, running at 215 r.p.m., as affording wide ranges of speed and load.

The engines were in every respect standard engines and ran with the air filters in position. During the tests the radiator fan was in full operation. In the main series of tests—A to F—the water circulating pump was running idly in water, while in one series—G—it was in operation, but, apparently, with no measurable difference to the brake horse-power. The leading particulars of the engines were as follows :—Two cylinders, of 80 mm.—3·15in. —bore, and combined piston stroke 300 mm.—11·8in. —normal r.p.m., 1100 ; maximum r.p.m., 1200 ; normal brake mean effective pressure, 6 atmospheres—85·3 lb. per square inch ; normal output at 1100 r.p.m., 45 H.P.

The observations made during the power tests, Series A to G, included : Fuel consumption, revolutions per minute, quantity and temperatures of circulating water, brake torque, exhaust temperature, pressure of the scavenge air. During the governor tests—Series H and J, revolutions per minute, circulating water temperatures and brake torque only were recorded, while during the tests of volumetric efficiency—Series K—revolutions per minute, the pressure of the scavenge air, and the readings of the air measuring manometer were recorded.

The fuel consumption was found by noting the time taken to consume a certain volume of fuel between two marks on a measuring vessel. The measuring vessel and the stop-watches were afterwards checked and found to be correct. The revolutions of the engine were obtained, simultaneously with the fuel consumption, by a revolution counter. The quantities of circulating water were found by weighing the amount passing in a known interval of time. The power developed by the engines was absorbed and the torque measured by hydraulic brakes. These were afterwards disconnected and balanced, and the arms measured. The brake constants given by the firm proved to be correct. The exhaust temperature, taken only in Series G, was measured by means of a shielded mercury thermometer placed directly in the gases ; the thermometer was not checked. Samples of the exhaust gases were taken during certain of the tests.

In this engine, it will be recalled, the induction air passes to the scavenging pumps, where its pressure is raised, and is then delivered into the engine body, which serves as an equalising air chamber, and thence to the cylinders. The pressure of the air in the engine body was measured on a mercury U-tube manometer. In the tests of air consumption the air filters were taken off and the air led from the test-house, through a German standard nozzle, of 50 mm. diameter at its smallest cross-section, into a tank, of about 10 cubic feet volume, which served to damp out fluctuations, and from there to the engine. The difference of pressure between the atmosphere and the tank, *i.e.*, the pressure drop over the nozzle, was measured by a water U-tube manometer. In calculating out the results a coefficient of discharge for the nozzle of 0·96 was taken.

The fuel used was a gas oil of specific gravity 0·876 at 68 deg. Fah., and having a lower calorific value of 18,190 B.Th.U's per pound. When subjected to fractional distillation it distilled over from 421 deg. to 689 deg. Fah. When tested in the open its flash point was 176 deg. Fah., and in the Pensky-Martin closed test a figure of 164 deg. Fah. was obtained. The viscosity of the fuel at 68 deg. Fah. was 1·38 deg. Engler. The specific gravity of the fuel was checked during the tests, and the above physical particulars were supplied by the Junkers material-testing department.

As already stated, Series A to G were power tests. Of these Series A to F were made on engine No. 7006, while Series G was made on engine No. 7031. The principal test data from Series A to F are given in Table I., and those from Series G in Table II. The results for all these series are shown plotted in Figs. 8 to 10. Fig. 8 gives the fuel consumption in pounds per B.H.P. per hour plotted on a base of brake mean effective pressure, the curves of Series A to F being shown by firm lines, and that of Series G by a dotted line. The maximum values of the brake mean effective pressure for the Series A to F are shown plotted on a base of revolutions per minute in Fig. 9. The resultant curve gives, very closely, the maximum output it was possible to obtain from this engine, under the conditions of the tests, and with the particular setting of the fuel pump.

Comparison, on Fig. 8, of the curves from these series with that of Series G, and on Fig. 9 of the position of the point giving the maximum brake mean effective pressure in Series G with the curve of maximum brake mean effective pressure, shows a marked difference in the characteristics of the two engines. On Fig. 8, for example, it will be noticed of Series A to F from engine No. 7006, that only in the series at low speeds are the points of m nimum fuel consumption passed, while in the series at the two highest speeds it has not yet been reached. In all of these tests the exhaust was quite clear throughout, with the exception of the highest outputs at each speed, when it was slightly hazy. This limit to the output was arranged deliberately so that, on the one hand, the exhaust should always be clear, and, on the other hand, the driver could not determine the maximum load on the engine. Such conditions are naturally controlled by the setting of the fuel pump for the maximum quantity of fuel at each speed. It was thought desirable to test an engine on which, at normal speeds of revolution, this limit to the output was not set quite so close. Engine No. 7031 was, therefore, taken from a different series, and, as will be seen from Figs. 8 and 9, this gave a maximum brake mean effective pressure at 1140 r.p.m., higher by 7 lb. per square inch than engine No. 7006. Further, although the exhaust from this engine at maximum output was still only slightly more coloured than that of engine No. 7006, the curve of fuel consumption appears to have just passed its minimum value. It would have been interesting to have tested on an engine upon which the output was not so limited ; but, since the tests were confined to engines intended for immediate service, this could not be done.

Considering the fuel consumption from the first engine, it is seen that, if the lowest and highest speeds be neglected, this did not exceed 0·5 lb. per B.H.P. per hour from brake mean pressures of 50 lb. per square inch upwards and at speeds varying from 500 to 1050 r.p.m. That from the second engine was even more favourable. Thus, in addition to good thermal efficiency, the design shows good flexibility with respect to changes of load and speed. This is further indicated by the curves of Fig. 10, of the heat given to the circulating water in B.Th.U. per B.H.P. per hour plotted on B.M.E.P., the uniformity of these curves over speeds from 700 to 1200 r.p.m. showing that the variation in combustion is small. The curve of exhaust temperatures is given for reference. As a further check upon the efficiency of the combustion, samples of the exhaust gas were taken during Series A, at 1200 r.p.m., at brake mean pressures of 4·3 lb., 81·1 lb. and 89·1 lb. per square inch, corresponding to no load, normal load and maximum load respectively. These were tested for carbon-monoxide in the works laboratory by the method of Schaepfer and Hofmann*, for which an accuracy of 0·005 per cent. of CO is claimed. The results were as follows :—

Sample No. 1 ..	0·089 per cent. CO ..	No load
Sample No. 2 ..	0·081 per cent. CO ..	No load
Sample No. 3 ..	0·126 per cent. CO ..	Normal load
Sample No. 4 ..	0·131 per cent. CO ..	Normal load
Sample No. 5 ..	0·192 per cent. CO ..	Maximum load

Since, as earlier stated, the exhaust was not quite clear at maximum load, when sample 5 was taken, the figure given does not completely represent the inefficiency of the combustion under these conditions.

The values of the maximum B.M.E.P., or torque,

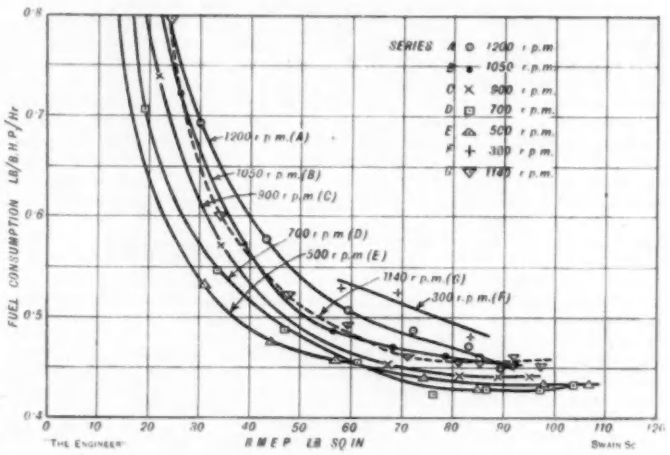

FIG. 8

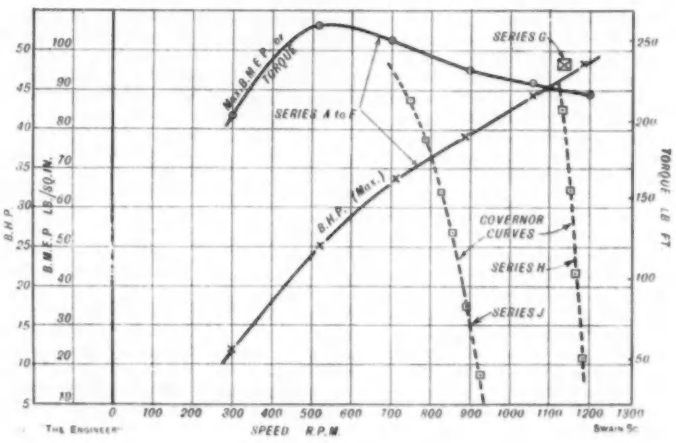

FIG. 9

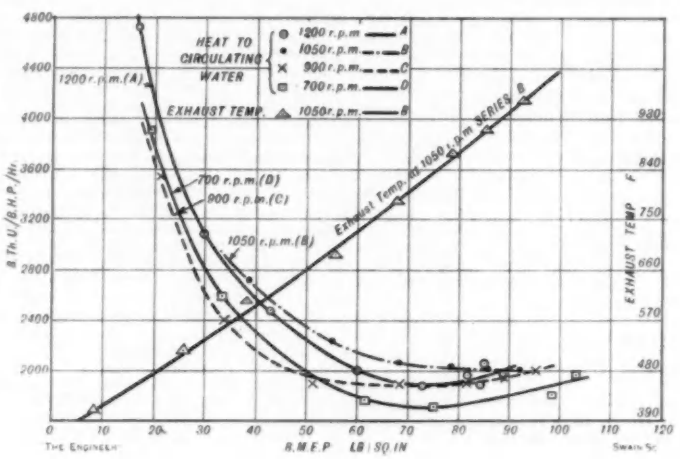

FIG. 10

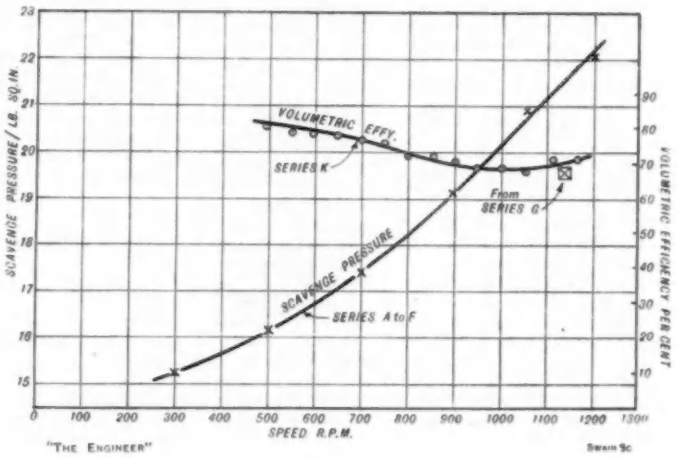

FIG. 11

* No. I. appeared September 5th.

* "Monats-Bulletin d. Schweizerischen Vereins von Gas u. Wasserfachmaennern," Nos. 10 and 12, 1927, Bericht No. 25.

plotted in Fig. 9 show that the output or torque given by the engine when accelerating is satisfactory, and reference to Table I. shows the corresponding figures for the fuel consumption to be low.

The engines tested were intended for transport purposes, and in this case the speed only of the engine is regulated by the hand lever, or by the accelerator pedal—see lever H in Fig. 4 *ante*. For any position of the lever, corresponding to any desired speed, the governor adjusts the fuel supply, and therefore the power output, in accordance with the load imposed upon the engine. In order to determine the manner in which the governor performed this function, the two series of tests—H and J—were carried

TABLE I.

Test No.	Speed, r.p.m.	B.M.E.P. lb./sq. in.	B.H.P.	Fuel, lb. per B.H.P. per hr.	Cooling water, B.Th.U. per H.P. per hr.	Mean scavenge press., lb./sq. in. abs.
A. 1	1180	89·1	48·5	0·449	1,970	22·1
2	1183	83·3	45·5	0·468	1,910	,,
3	1198	72·6	39·0	0·485	1,900	,,
4	1206	81·1	45·2	0·454	2,050	,,
5	1199	59·8	33·1	0·504	2,010	,,
6	1191	42·7	23·5	0·576	2,490	,,
7	1197	29·9	16·6	0·694	3,090	,,
8	1190	17·1	9·4	0·968	4,760	,,
9	1192	4·3	2·4	3·120	11,550	,,
10	1192	85·4	47·1	0·458	2,030	,,
B. 1	1056	91·8	44·7	0·451	1,990	20·9
2	1055	85·4	41·6	0·454	1,990	,,
3	1053	79·0	38·4	0·459	2,000	,,
4	1050	68·3	33·2	0·470	2,030	,,
5	1051	55·5	26·9	0·487	2,190	,,
6	1049	38·4	18·6	0·575	2,700	,,
7	1050	25·6	12·4	0·720	—	,,
8	1045	8·6	4·1	1·615	—	,,
C. 1	895	95·5	39·4	0·443	2,010	19·1
2	896	89·6	37·0	0·443	1,950	,,
3	897	81·1	33·6	0·442	1,910	,,
4	894	68·3	28·2	0·452	1,920	,,
5	894	51·2	21·1	0·482	1,890	,,
6	894	34·2	14·1	0·571	2,400	,,
7	904	21·4	8·9	0·742	3,550	,,
8	893	4·3	1·76	2·71	16,900	,,
D. 1	705	103·4	33·7	0·436	1,980	17·4
2	696	98·0	31·4	0·430	1,800	,,
3	693	86·0	27·5	0·431	1,880	,,
4	694	74·9	24·0	0·429	1,720	,,
5	688	61·0	19·4	0·455	1,760	,,
6	702	47·0	15·2	0·489	2,140	,,
7	704	33·3	10·84	0·547	2,590	,,
8	694	19·4	6·22	0·704	3,900	,,
9	695	5·6	1·78	1·970	12,100	,,
E. 1	510	107·0	25·1	0·436	—	16·2
2	495	98·5	22·5	0·436	—	,,
3	490	85·3	19·3	0·432	—	,,
4	500	73·6	16·8	0·443	—	,,
5	505	57·9	13·6	0·457	—	,,
6	495	44·4	10·15	0·476	—	,,
7	510	30·6	7·20	0·535	—	,,
8	508	13·9	3·26	0·839	—	,,
F. 1	302	83·7	11·7	0·481	—	15·3
2	299	69·7	9·60	0·521	—	,,
3	310	57·9	7·99	0·527	—	,,

TABLE II.

Test No.	Speed, r.p.m.	B.M.E.P., lb./sq. in.	B.H.P.	Fuel, lb. per B.H.P./hr.
G. 1	1140	97·0	51·1	0·451
2	1140	91·6	48·3	0·456
3	1139	85·2	45·0	0·453
4	1140	81·0	42·7	0·454
5	1137	70·3	37·0	0·463
6	1143	59·7	31·5	0·492
7	1143	46·9	24·8	0·522
8	1140	34·1	17·9	0·600
9	1133	21·4	11·2	0·798

TABLE III.—*Governor Tests.*

Series H.		Series J.	
B.M.E.P., lb./sq. in.	Speed, r.p.m.	B.M.E.P., lb./sq. in.	Speed, r.p.m.
21·3	1181	0·8	940
42·6	1166	17·1	917
64·0	1147	34·1	892
85·3	1121	53·3	852
—	—	64·0	830
—	—	76·8	781
—	—	87·5	743

TABLE IV.—*Air Consumption Tests, Series K.*

Manometer, mm. water.	Speed, r.p.m.	Manometer, mm. water.	Speed, r.p.m.
137	1158	68	799
115	1108	64	745
104	1051	59	701
95·5	997	52	646
89	953	45	595
81	898	39	552
75	845	33	497

out. In Series H the lever was set to give the highest speed, and in Series J it was set for a somewhat lower speed. For each position the load on the engine was varied progressively from light to full load, the corresponding speeds of the engine being observed. The results are given in Table III., and are plotted as B.M.E.P. and torque on a base of revolutions per minute in Fig. 9, and show that the governor controls the speed in a satisfactory manner. The curve for Series H further indicates that, in addition to the limits referred to earlier that are imposed by the fuel pump upon the B.M.E.P., the speed of the engine is also definitely limited by the governor to about 1200 r.p.m.

The observations from the series of tests, Series K, made to measure the volumetric efficiency of the scavenging pumps, are tabulated in Table IV. The area of the plunger of the scavenging pump was 216 square centimetres—33·5 square inches—and the stroke 15 cm.—5·9in. The air temperature during the series was steady at 64·4 deg. Fah., the barometer reading being 29·5in. The volumetric efficiency is plotted on a base of speed in Fig. 11, and is defined as the ratio of the actual weight of air used in unit time, to the weight of air at 64·4 deg. Fah. and 29·5in. of mercury to fill the swept volume in the same time. The figures given should be multiplied by 0·925 to reduce them to the conventional, if irrational, N.T.P. basis. The readings of the scavenge pressure for Series A to F are also plotted in Fig. 11. Neither the volumetric efficiency nor the scavenge pressure vary very much with the load on the engine, the volumetric efficiency being highest and the scavenge pressure lowest at no load. The volumetric efficiencies shown on the curve were taken at no load, and the scavenge pressure at normal load. A point from a single test of volumetric efficiency taken at a brake mean pressure of 60 lb. per square inch during Series G is shown for comparison.

Both engines ran satisfactorily throughout all the series of tests. There was a complete freedom from vibration, and the noise was no more marked than that from a petrol engine of similar speed and power.

B.E.S.A. Specifications.

THE following specifications have just been issued by the British Engineering Standards Association :—

SHORT LINK WROUGHT IRON CRANE CHAIN.

This specification is the first of a series of specifications which is in course of preparation as the result of representations made by the Home Office, for the standardisation of chains and chain fittings. Two qualities of chain are specified, a "standard quality," which it is felt is adequate for all normal lifting purposes; and a "special quality," which is included to meet those cases in which special hazards and risks are involved. The specification provides for clauses governing the quality of material used in the chain as well as standardising dimensions and test loads. The tests determining the quality of the material are to be carried out on a sample cut from the chain itself, and the finished chain is thus tested both as regards quality of material and tensile strength.

Another feature in which the specification differs from others previously drafted is that the elongation on a 36in. sample is to be measured at a point before fracture at a load which is given as the test load, which must accordingly not be confused with the breaking load. The requirements for testing machines used for carrying out the tests on the chain are included in an appendix.

The Committee responsible for the preparation of this specification was assisted in its work by both the Chain and Anchor Manufacturers' Association and the National Physical Laboratory, which collaborated in the tests that were carried out with a view to establishing the suitability of the tests laid down.

STEEL FORGINGS, BLOOMS AND CASTINGS.

This is a revised edition of Part IV. of Report No. 24. The forging and casting specifications cover four qualities of material, and in the revision certain modifications have been made to the requirements of these classes.

The specification for forgings has also been amplified to cover rolled bars of Class D and Class D quality of material.

ATTACHMENT OF CIRCULAR METAL CUTTING SAWS.

The need for some standard method of attachment of circular saws to their spindles has long been recognised. This specification provides for the attachment of saws from 10in. up to 60in. and over in diameter in six ranges. The loose flange method of attachment is recommended, and in addition to giving the standard dimensions for the fixing of the saws, the specification also includes a recommended method by means of which two ranges of saw diameters can be accommodated on one size of machine. In preparing this specification the dimensions of machines at present in use were carefully considered.

WROUGHT LIGHT ALUMINIUM ALLOY SHEETS AND TUBES.

These two specifications cover the light aluminium alloy generally known as duralumin. Both contain clauses for the chemical composition of the alloy and the physical properties of the finished material, whilst tolerances on the dimensions of the sheets, strips and tubes are also given.

Copies of the foregoing specifications may be obtained from the Publications Department, British Engineering Standards Association, 28, Victoria-street, London, S.W. 1, price 2s. 2d. each post free.

Canadian Engineering News.

Experiment with Cobalt Ores.

FLOTATION of cobalt ores yielding a 20 per cent. concentrate and with a comparatively small loss in recovery is now possible as a result of developments in the chemical branch of the mining industry, according to D. H. Halford, who has been carrying out experiments with cobalt ores in the mines branch laboratories at Ottawa. The bulk of the cobalt has been produced as a by-product of silver. In the ordinary treatment of silver, a great proportion of the cobalt was lost, concentrates running only as high as 6 or 7 per cent., with recoveries around 50 per cent. Development of the new reagent, which may be manufactured in Canada, means that the annual production of cobalt from the same amount of ore may be doubled in future. The Agaunico Mine, near Sudbury, which is operated entirely on cobalt ores, is reported to have tentative plans for a cobalt mill, in order to supply "flotagen," as the new reagent is called, to the other mills of the camp.

Ontario's Iron Deposits.

The most significant development in connection with the Northern Ontario mining fields in the last few months is the attention that is being paid to the iron and pyrites deposits of Algoma by large American interests, such as the Du Ponts and the Bethlehem Steel Corporation, both of which have been examining properties. Good progress is being made in the electrical survey of pyrites properties in the Michipicoten-Goudreau area, which is being made by the Radiore Company for Canadian Pyrites, Ltd., the company which has charge of mining activities of the Du Pont interests in Canada. The Du Pont companies, which form one of the most important industrial groups in the United States, a few months ago absorbed the Grasselli Chemical Company, itself an 80,000,000 dollar concern, and it is through this merger that the Du Pont interests have come into the Algoma mining fields. The Grasselli Company, a few years ago, purchased the Holdsworth pyrites claims, near Hawk Junction, and it is on this property, now controlled by Canadian Pyrites, Ltd., that the electrical survey was commenced. The company has taken options on two other prospects, both lying east of Alden and both controlled by a group of Sault Ste. Marie men, on which surveys are also to be made to determine what size of an ore body exists. Difficulties arising with the operation of the sulphur deposits in the United States, combined with the success of recent experiments for the use of pyrite and similar ores for the production of various sulphur compounds, have again directed attention to the Algoma deposits. During the war a considerable quantity of pyrites ore was mined by the Nichols Chemical Company, near Goudreau, but the falling off of the demand occasioned by the war caused the operations to be suspended.

Electricity on Prairies.

Saskatchewan is the latest of the Prairie Provinces to develop an active interest in hydro-electric power. The Power Commission of the province is making inquiry this year into the question of the development of the Saskatchewan river as an immediate prospect. The first great hydro-electric station in the province came into operation only recently, when the Island Falls plant on the Churchill River commenced to operate. This plant, however, is in the northern part of the province, and its purpose is to supply power for mining and for the metallurgical treatment of the ores discovered in Northern Manitoba and Saskatchewan. Moreover, it is a privately owned plant built by the Churchill River Power Company, primarily for the supply of power to the Flin Flon and Sherritt-Gordon mines in Northern Manitoba. The Saskatchewan Power Commission, on the other hand, is operating in the southern half, or agricultural territory, of the province, and its present move is to utilise the water power of a stream more conveniently situated to supply the electrical needs of the vast majority of the people in the province. So far, the electrical power under the Commission's jurisdiction is steam-generated, and the most important plant is that taken over from the city of Saskatoon and subsequently enlarged. It is to be the centre of a network of transmission lines distributing power over a large part of the central portion of the province. This year the Commission is building 750 miles of transmission lines to serve sixty or seventy centres in various parts of the province, the whole programme in this respect to cost probably 2,500,000 dollars.

Huge Natural Gas Projects.

Great interest has been awakened in Western Canada in new proposals to supply the city of Regina, Saskatchewan, with natural gas. The proposals involve the spending of many millions of dollars in piping the gas from Alberta fields and in the laying of gas mains for a city distribution system. Besides Regina, the cities of Saskatoon, Moose Jaw and Swift Current are included in one or more of the proposals, which are made by financial interests in the United States.

Regina appears to be the king pin in the several schemes to supply natural gas to Saskatchewan cities, and Regina has received three separate offers from as many companies. The Dominion Gas and Electric Company, the new holding company organised by the American Commonwealth Power Corporation and the American Utilities and General Corporation, which has just acquired all the interests of the International Utilities Corporation in Western Canada, is one of the companies which has come forward with a proposition. Among these are the Canadian Western Natural Gas, Light, Heat and Power Company, supplying natural gas to the cities of Calgary, Lethbridge, and a number of Southern Alberta towns, and the Northwestern Utilities, Ltd., supplying natural gas from its wells in the Viking field to Edmonton and intervening towns. The Calgary company has its own gas field at Foremost, Alberta, but is obtaining its supply at present mainly from the Turner Valley gas and oil field south-west of Calgary.

The Turner Valley, in which enormous quantities of natural gas are being produced over and above what there is a market for in the Calgary vicinity, is nearly 450 miles west from Regina. About one-third of the distance is, however, already traversed by the pipe line of the Canadian Western Natural Gas, Light, Heat and Power Company. This pipe line, 200 miles in length, connects the company's Foremost gas field to Calgary and also the older Bow Island field, about 30 miles north of Foremost, which originally supplied Calgary's requirements. Arrangements are at present in hand to use this pipe line to transport natural gas in the reverse direction, surplus from Turner Valley to be forced into the wells in the Bow Island field. Certain wells have been repaired and the re-charging is to proceed immediately, the Bow Island field then to serve as an emergency reservoir for the whole system operated by the Canadian Western Natural Gas, Light, Heat and Power Company. A 300-mile extension of the system easterly would make Turner Valley and Foremost gas available in Regina.

An Eight-wheeled Four Steering Vehicle.

SOME months ago we noticed on the roads in the Midlands a steam-driven vehicle of unusual dimensions, which was carried on eight wheels, and appeared to run exceptionally smoothly. It aroused our curiosity, which has just been satisfied by a demonstration at the Sentinel Waggon Works, Ltd., Shrewsbury. The vehicle in question is illustrated by the half-tone engravings below and its more interesting parts by the accompanying drawings.

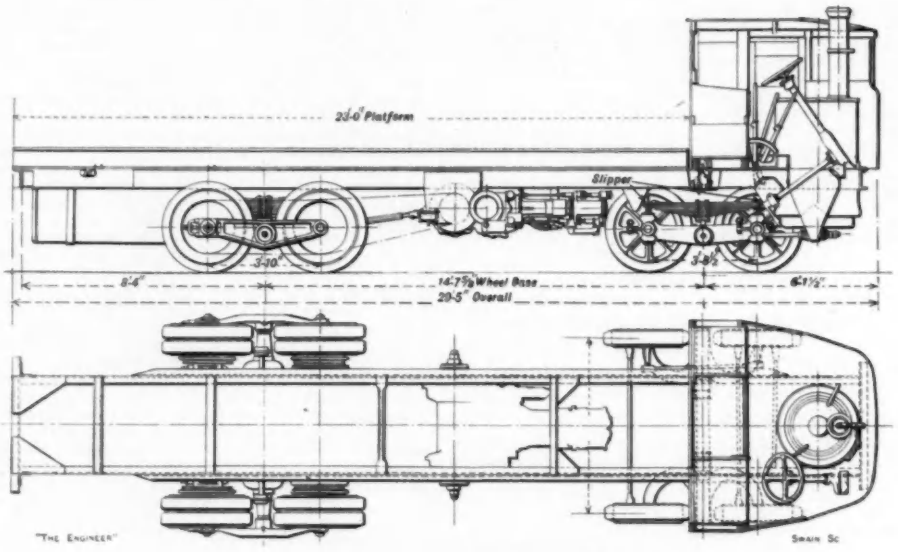

FIG. 1—SIDE ELEVATION AND PLAN OF VEHICLE

We have on several occasions—see THE ENGINEER, July 13th, 1928—dealt with the characteristic features of the "Sentinel" steam wagon, with its horizontal, high-pressure, steam engine and tubular boiler, which is capable of producing about 120 horse-power, so that it is unnecessary to enlarge upon that part of the equipment of the new wagon. It is virtually the same as that of the makers' standard six-wheeler, and we could not observe, in going round the shops at Shrewsbury, that there was appreciable difference between the power unit for the new eight-wheeler and the six-wheeler, of considerably less capacity. Some few improvements have, however, been made, but will be common to all the wagons built by the company, regardless of their wheel arrangement. Thus the lighting dynamo is now driven off the main crank shaft by means of enclosed cut gearing, instead of through an exposed bicycle chain, and the cylinder lubricator, at the opposite end of the crank shaft, is also driven by enclosed gearing. The engine retains the cylinder size of 6in. bore by 8in. stroke. The engine casing embodies a spur reduction gearing and thence the drive is transmitted from the differential gear to the front pair of rear wheels, through roller chains. The back pair of wheels is driven by a secondary set of chains and sprockets, so that there are four drivers.

So far the arrangement of the machine follows the standard "Sentinel" design, but the wheel arrangement is distinctly novel, as may be seen from the drawing, Fig. 1. In order to carry greater loads than the normal six-wheeler, which is capable of taking up to 15 tons, it was obvious that more wheels would be necessary or the axle loads would become so heavy as to damage the majority of roads. It was decided to add two more wheels at the front of the vehicle, and all four front wheels must, or course, be steerable, but it has been found unnecessary to make the back wheels steerable, as the rubber tires accommodate the slight difference in angular movement between the front and rear axles.

With the front, steering, wheels the matter is, however, different, as is indicated in the diagram, Fig. 5. On the supposition that the centre of the circle round which the vehicle turns is on the extension of a line parallel to and equally between the two rear axles, as indicated in the diagram, each of the four front steering wheels will have to be turned through a different angle if skidding is to be avoided.

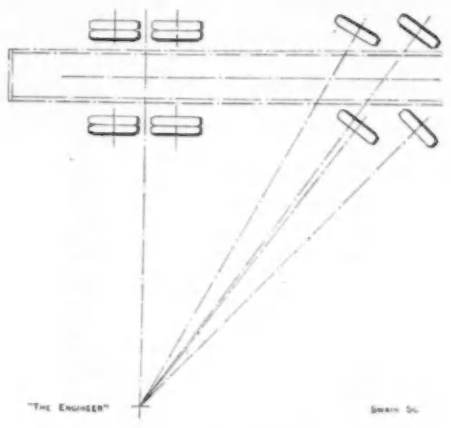

FIG. 5—DIAGRAM ILLUSTRATING STEERING

The Ackermann system of steering is, of course, familiar for this purpose in the case of one pair of front wheels, and is, in this case, adopted in a modified form for all four steering wheels. As will be seen from the drawing, Fig. 3, the foremost wheels are connected together by the usual track rod and levers, which give the two wheels the appropriate relative angles for turning. This linkage is connected with the second pair of steering wheels by a longitudinal rod and two crank arms. These arms are of such a length that they set the second pair of wheels at greater angles than the front pair. This effect is plainly shown in the engraving, Fig. 6. The two rear steering wheels are, of course, also connected together by a track rod. The relative lengths of the two crank arms of the

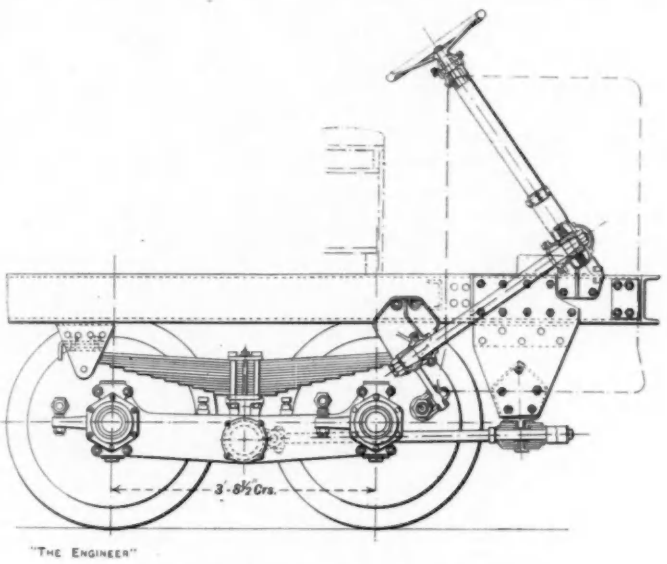

FIG. 2—SIDE ELEVATION OF STEERING BOGIE

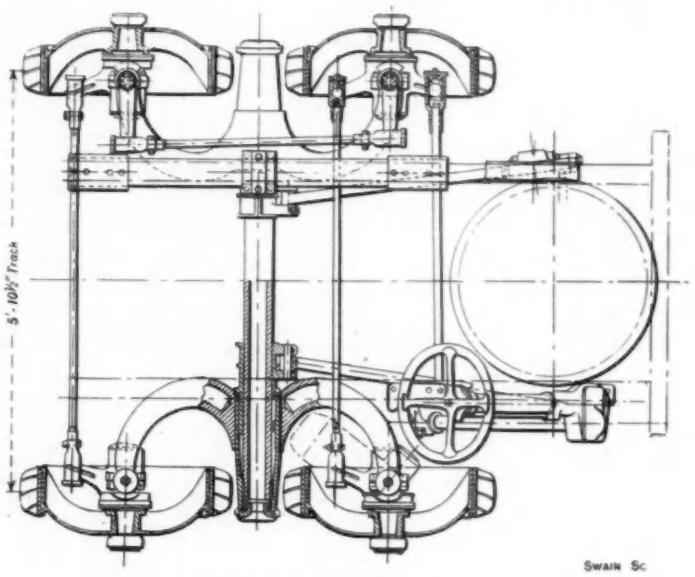

FIG. 3—PLAN OF STEERING BOGIE

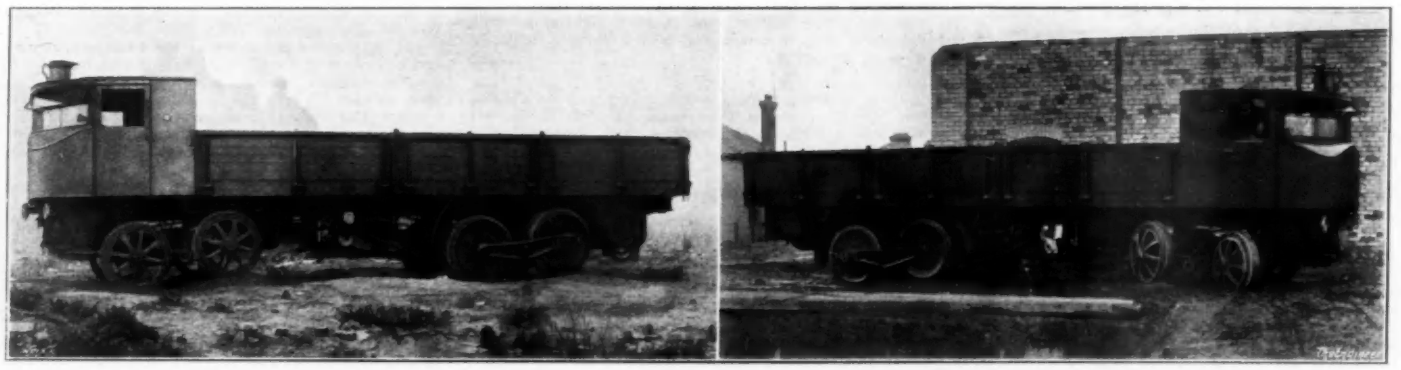

FIG. 4—EIGHT-WHEELED, FOUR-STEERING "SENTINEL" WAGON

connecting link are dependent on the distance apart of the axles, and give, as near as is possible with the Ackerman principle, a true set of steering angles.

The steering column is of the normal style, but at the bottom there is a screw and crank arm connection, which alters the angle through 90 deg., so that the second part of the column rakes towards the rear, downwards. At the bottom of this second part there is the usual crank for operating the track rod. It is noteworthy, in view of the weight carried by these steering wheels, that the driver does not have to make any great exertion in turning corners, and during a short trip in the country which we made on one of these vehicles, we noticed, not only by observation, but also by conversation, that the machine is quite easy to handle. It is also noteworthy that, on account of the greater adhesion provided by the four steering wheels, they can be locked round harder than is possible with only two wheels without there being any fear of the wheels skidding forward.

The two groups of four wheels are mounted on what the makers term bogies, although they are not bogies in the sense that a railway engineer uses the expression, as they do not turn about a single vertical axis. Taking first the back wheels. Each pair is mounted on short axles between cast steel side frames. The bearings are of the roller type. The side frames are pivoted at their centres on a heavy axle which runs right across the vehicle. This axle is mounted on semi-elliptic springs, and is kept in position by radius rods. The springs include several auxiliary leaves which only come into action when the vehicle is fully loaded, as there is a certain amount of "daylight" between their ends and the pads at light loads. There are definite stops to prevent the overstressing of the springs in the case of bad usage.

The front wheels are carried in a rather different fashion, as there must be accommodation for their steering motion. The framework for this purpose is plainly shown in Fig. 3, and consists of a main axle on either end of which there is pivoted a Y-shaped frame. These frames are hollow stampings of steel, and are a fine tribute to the

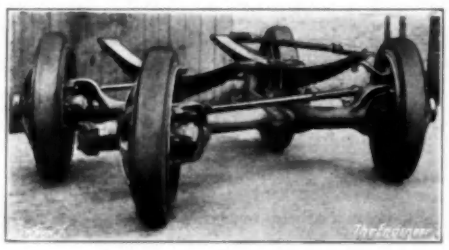

FIG. 6—THE STEERING BOGIE

art of the drop forger. They are, we believe, made straight, like a T, and are then bent round to the curved form shown in the drawing. Each arm of each Y is, of course, equipped with a steering pivot and bearing for its wheel, which is of the dished type, to bring the centre of pressure directly over the tread.

The result of this arrangement is that all the wheels, on either side of the vehicle, are on equalising beams, and, regardless of the inequalities of the road surface, each wheel bears its fair proportion of the load.

We have tested this feature by running the vehicle over a number of obstacles, such as railway sleepers and rough ground, with, in some cases, only one wheel of the whole eight elevated by the obstacle, but could not observe in sighting the chassis any distortion of the frame.

Below we give the leading dimensions and particulars of the new machine in tabular form :—

"*Sentinel*" *D.G.* 8 *Rigid Eight-wheeler* :	*Leading Particulars.*
Overall length	29ft. 5in.
Overall width	7ft. 6in.
Body—	
Overall length	23ft.
Inside length	22ft. 9in.
Inside width	6ft. 9in.
Wheel base, centre to centre of bogies	14ft. 7⅛in.
Leading wheels to rear wheels on front bogie, centres	3ft. 8½in.
Leading wheels to rear wheels on rear bogie, centres	3ft. 10in.
Wheel track—	
Front bogie	5ft. 10in.
Rear bogie	5ft. 9½in.
Height of platform, laden	4ft. 0½in.
Size of tires—	
Front wheels } Fitting	8in. by 720 mm.
Rear wheels, twin } diameters	160 mm. by 771 mm.
Engine, bore by stroke	6in. by 8in.
Boiler pressure	275 lb. per sq. inch
Capacity of coal bunker	10 cwt.
Average fuel consumption with full load	14 miles per cwt.
Capacity of water tank	230 gallons
Capacity of water tank, with full load	27 miles
Approximate engine speeds—	
High gear at 12 m.p.h.	435 r.p.m.
Low gear at 6 m.p.h.	650 r.p.m.
Pitch of driving chains	2in.
Will pull up dead on wet road from 12 m.p.h. in	22ft.
Minimum turning radius	33ft.

ACCORDING to the Railway Returns for 1929, the number of steam, electric and petrol locomotives on British railways at the end of the year was 23,454, a decrease, when compared with 1928, of 212. The total empty weight of steam locomotives decreased from 1,080,799 tons to 1,079,716 tons, but the average empty weight for locomotives increased from 45·76 tons to 46·13 tons. There were 551 locomotives completely renewed, as compared with 664 in 1928, and the number under and awaiting repair at the end of the year was 1964, or 8·12 per cent. of the total stock. In 1928 the percentage was 9·24 and in 1927 it was 11·10.

The Use of Non-Ferrous Metals in the Aeronautical Industry.*

By Professor D. HANSON,† D.Sc.

THERE are certain features that are fundamental to the design of aircraft, whether it be the structure of aeroplanes or airships, or the power unit. The requirements differ somewhat in the two cases. In both instances it is essential that the materials used shall be strong for their weight. In the case of both aeroplanes and airships we must fulfil the additional requirement that the structure as a whole shall be very light for its size ; in the case of the power unit the engine must be light in relation to the power developed, although it may be, and in fact always is, a very compact unit that is distinctly heavy for its size. An intelligent understanding of the materials and methods of construction used is only possible in the light of these fundamental requirements.

Dimensional theory clearly demonstrates the difficulty of maintaining low total weights as the size of a structure increases. The reduction of sections in the different members introduces problems of stability, and great care is required in design if local failure under stress is to be avoided in the struts, beams, and other members in which compression, bending, and shear forces predominate. In the engine, with its compact structure, stability problems do not arise in anything like the same degree, but others take their place. For example, many parts, such as pistons, cylinders, &c., must be of a form that can be conveniently cast ; pistons and valves must be able to work continuously at high temperatures ; crank shafts require a high resistance to fatigue, gears must resist wear, and so on. In every instance the material selected, especially for highly stressed parts, has to fulfil some special function, while at the same time it should preferably be made of the lightest material suitable for the particular application. Other things being equal, any saving in weight enables the designer to obtain greater speed, or additional carrying capacity, or a wider range of action, or some combination of these ; and the commercial future of aircraft of all types is in a large manner dependent on the weight reductions that can be achieved without sacrificing other desirable properties.

The relation between strength and lightness in the different materials can best be expressed by dividing the mechanical properties by the specific gravity ; the strength properties may be represented by the ratios : maximum stress/specific gravity : proof stress/specific gravity : fatigue range/specific gravity, and so on, while the rigidity comparisons are obtained from the ratio—Young's modulus/specific gravity. Some of these properties are set out in Tables I., II., and III., for some typical strong aircraft materials.

TABLE I.—*Specific Tenacities for Various Strong Aircraft Alloys.*

Material.	Maximum strength, tons/sq. in.	Specific gravity.	Specific tenacity.
Steel	50	7·8	6·4
Nickel-chromium steel (heat-treated)	90	7·8	11·5
Stainless steel (austenitic, cold-worked)	65	7·8	8·3
Duralumin	26	2·8	9·3
Duralumin (cold-worked)	30	2·8	10·7
Elektron VI., magnesium alloy (heat-treated)	22	1·8	12·2
Monel metal (cold-rolled sheet)	56	8·8	6·3

TABLE II.—*Specific Proof Stresses for Various Strong Aircraft Alloys.*

Material.	Proof stress, tons/sq. in.	Specific gravity.	Specific proof stress.
Steel	40·0	7·8	5·1
Nickel-chromium steel (heat-treated)	65·0	7·8	9·3
Austenitic steel (cold-worked)	50·0	7·8	6·4
Duralumin	16·5	2·8	5·9
Duralumin (cold-worked)	22·0	2·8	8·0
Magnesium alloy, Elektron VI.	14·5	1·8	8·1
Magnesium alloy, Elektron AZM	11·0	1·8	6·1

TABLE III.—*Specific Modulus of Some Strong Aircraft Materials.*

Material.	Elasticity, tons/sq. in.	Specific gravity.	Specific modulus
Spruce	670	0·45	1·490
Steel	13,000	7·8	1·667
Duralumin	4,600	2·8	1·643
Magnesium alloys	2,790	1·8	1·550
Nickel alloys	13,800	8·8	1·570

The comparison is interesting and shows that there is a remarkable uniformity between the high tensile steels, the best aluminium alloys, and the best magnesium alloys at present available in regard to all these qualities, although the absolute values for the different properties differ greatly from one another. In regard to rigidity, the figures quoted apply to parts used in tension or compression ; under transverse or bending stresses rigidity depends also on the moment of inertia of the section, which increases rapidly with the linear dimensions, and the comparison is then much more favourable to materials of low density.

The importance of weight makes it very necessary in designing the structure of any aircraft to avoid any undue mass of metal, while the conditions under which aircraft are used make it equally necessary for the designer to ensure that failure shall not occur in any important member. It is therefore customary first to ascertain the loads or stresses associated with definite flight conditions, and then to design the members of the structure so that the maximum loads they can withstand bear a definite relation to the stresses under the assumed standard conditions ; the term "load factor" is used to express this ratio. The estimation of the stresses in service naturally involves the conventional assumptions of aerodynamics and structural theory, and the load factors have no real significance except when associated with these conventions. Nevertheless, the accumulated experience now available enables this method to be applied with success, and has resulted in the production of mechanically strong structures of extremely low weight. In fact, few engineering structures are so carefully and economically designed, from the point of view of the material used as those of modern aircraft, which have reached such a stage of perfection that failures in the important members are extremely rare.

Structural theory is based on the assumption of perfect elasticity in the materials used. Under actual service conditions, however, some slight deformation must be anticipated, although this must naturally be kept very small. In order to define the resistance of a material to permanent strain, the term "proof stress" has been used ; this is the tensile stress at which the plastic deformation is one-tenth of 1 per cent., and this figure, or something rather less, is used extensively for design purposes as the maximum stress which a material will withstand.

The case of members required to resist pure tension is relatively simple, and the lightest material is that with the highest specific tenacity or specific proof stress. For highly stressed parts of this nature, high tensile steel, preferably nickel-chromium steel in the hardened and tempered condition, is the lightest material available. The majority of aeroplane parts have to withstand compression or shear stresses, when difficulties at once arise. Any thin rod or flat sheet possesses an inherent lack of rigidity and becomes unstable in shear or compression, and is liable to fail by buckling or crumpling before the true strength of the material is realised. The selection of a suitable form of member is here a matter of importance. Tubes are largely used ; for the same weight of material, a tube is clearly more stable than a rod, but there is a point beyond which an increase in the diameter of a tube is no longer advantageous owing to the reduction in wall thickness necessary to retain lightness. In the same way, the stability of flat, or nearly flat, surfaces can be increased by giving them a crinkled or corrugated form, just as a corrugated iron sheet is more rigid than a flat one of the same thickness. Where weight is of primary importance, the denser and therefore the thinner the material chosen, the more acute is the necessity for corrugation, and the more complex must be the form of the member used. The complex girders and wing spars now in use are the results of efforts to improve stability without increase in weight, by suitable adjustment of the form of the particular member.

There is clearly a point beyond which reduction of thickness cannot be carried, partly because of the difficulty of designing and manufacturing suitable forms, and partly because of the practical difficulties encountered in making tubes or strips. Accuracy in manufacture is essential. Close limits on dimensions are required from weight consideration, since design has to be based on the minimum, whereas the weight of the finished structure, which has to be carried by the aircraft, depends on the mean thickness. Any lack of straightness seriously reduces the stability, and therefore the effective strength of a tube or spar. The importance of these requirements is indicated by the fact that specifications require strips and tubes to depart from straightness by less than one six-hundredth part of their length. The question of expense is also a material factor, since manufacturing costs rise rapidly as the ratio of thickness to overall size diminishes ; this is particularly the case with high tensile steel tubes, which are very difficult to produce except in the heavier gauges.

Much ingenuity has been expended in devising suitable forms, particularly for the more highly stressed members, such as the longitudinal and transverse girders of airships and the wing and tail spars of aeroplanes. Provided that suitable forms can be devised which will enable the full strength of the material to be developed before instability shows itself, the material with the highest specific strength will clearly produce the lightest member. In those members in which the above dimensional considerations will permit its use, nickel-chromium steel, treated to give a proof stress of about 65 tons per square inch, is suitable, and is often used in English aircraft for the main wing spars, the beams of the body girders, and so on. Duralumin is little inferior in specific strength ; it is distinctly easier to make in complex forms and is even more extensively used ; it is almost universal for parts subjected to moderate stresses, extra rigidity thereby being obtained. For airship work with one notable exception, it is almost universally employed. With the development of strong rolled magnesium alloys a further material is becoming available ; these alloys possess specific strengths as great or greater than the alloy steels, and appear capable of still further improvement, although on account of their low modulus of elasticity they are slightly inferior in specific rigidity—a quality which does not appear likely to be considerably improved by alloying. Although experience with them is as yet slight, and they are only in the early stages of their development, they have, nevertheless, shown sufficient promise to be included in the wing spars of the twelve-engined Dornier flying boat, and their development will be watched with great interest.

The stainless steels are other materials, containing a considerable amount of non-ferrous metals, which have also been used to some extent. The chromium stainless steels are little inferior in strength to the ordinary heat-treated nickel-chromium steels, but the austenitic alloys are soft and possess a low proof stress and ultimate strength in the normal condition, and suitable properties can only be obtained at present by cold working. Those materials have been used extensively in the British airship R 101 ; they will find further use in the future in aircraft construction on account of their rust-resisting qualities.

The primary importance of the strength : weight ratio has been emphasised, particularly with reference to highly stressed parts, but the possible use of ferrous alloys must not be exaggerated. Such a heavy metal can only usefully be employed in competition with the lighter materials available, if it is possible to reduce scantlings to such an extent as to justify the use of the heavier alloys. For all the parts subjected to medium stresses, such as the minor structural parts, as well as for the host of fittings, this is not possible, partly on account of the stability con-

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† Professor of Metallurgy, University of Birmingham.

siderations already referred to, and partly because of difficulties in manufacture, and for these purposes the light non-ferrous alloys are unlikely to be displaced.

AIRCRAFT NON-FERROUS ALLOYS.

We are accustomed to the use of the term "light alloys," as including those materials consisting largely of aluminium or magnesium, the common metals possessing a low specific gravity. These are light metals in the usual sense of the word, since the weight of unit volume is low. They are not necessarily light in the engineering sense, and particularly not from the standpoint of the aeronautical engineer, who desires low weight per unit of strength. For his purposes commercial aluminium is a "heavy" metal, notwithstanding its low specific gravity, because it is weak. Steel is strong, and, from the engineer's point of view, one of the "light" metals. Aluminium and magnesium alloys and the high-strength alloy steels are the light metals of the aeronautical engineer.

Among the non-ferrous alloys those of aluminium are at the present time by far the most important; the only serious rivals in sight are magnesium alloys, which are now undergoing rapid development and are steadily finding application in many directions. In many respects the two types are competitive, and while there are distinct differences between them, for many purposes their performances are closely similar, and the future will therefore be watched with considerable interest.

Aluminium Alloys.—The classification of the strong aluminium alloys is relatively simple, for the reason that useful alloys are formed with but a limited number of other metals, and of these few metals one is of outstanding importance both in castings and wrought alloys. With only one or two important exceptions, the principal strong alloys of aluminium contain copper as the chief alloying element—in some cases the only one. In these instances the properties depend mainly or wholly on the influence of copper on aluminium, and could not be obtained by any other known elements or by any combination of elements that did not include copper. So much is this the case that it is no exaggeration to say that, were we limited to one element alone for making aluminium alloys, and could choose copper, we should be able to produce strong alloys of all types, not quite as good as the best at present available, but not markedly inferior. Copper has, in fact, the same importance for aluminium alloys as carbon for the steels. This is in part due to the formation of the compound $CuAl_2$, which forms a eutectic with aluminium, but more especially to the solubility of this compound in aluminium, and the changes of solubility with temperature, which permit the application of a form of heat treatment that has a very beneficial effect. Next in importance, perhaps, are silicon and magnesium; silicon and aluminium form important casting alloys, while magnesium, especially in combination with silicon or copper, contributes to the production of high-grade cast and wrought alloys, and the development of their properties through heat treatment.

Nickel and zinc are also important metals, each of which enters, with copper, into important strong alloys. There remain only manganese and iron; manganese is an improving, though not a major, constituent in duralumin and similar strong wrought alloys, and iron is sometimes intentionally incorporated in castings to withstand wear. Traces of sodium, titanium, and other metals are used for special purposes, but the above substantially represent the useful alloys. The number is small, having regard to the possible combinations; no doubt some remain to be discovered, but it is clear that aluminium is an unsociable metal by nature, that it makes few friends, and is on terms of close friendship only with one.

Wrought Alloys.—All the wrought high-strength aluminium alloys depend on the process of heat treatment for their useful mechanical properties, and one or both of the constituents $CuAl_2$ and Mg_2Si contributes in all cases to the development of these properties. It will, perhaps, be most convenient, as well as most logical, to consider them according to their hardening medium, when they can be adequately classified in three types:—

(1) *Alloys Hardened by Copper.*—In these alloys in which $CuAl_2$ alone is the hardening medium, it is usual to add a little silicon or manganese, or both; these elements improve the casting and working properties, but do not essentially modify the mechanical properties of the final heat-treated alloy. Artificial ageing is essential.

(2) *Alloys Hardened by Mg_2Si.*—As a rule, these alloys also are made with some addition of silicon above that necessary to form Mg_2Si, and sometimes manganese is added.

(3) *Alloys Hardened by both Copper and Mg_2Si.*—This is the most important group, and it includes the well-known duralumin, the best known and by far the most commonly used of the wrought strong light alloys. It is now made under many names, either in its original form or modified slightly in composition; the most important modifications are those that have led to the alloys most commonly known as "Y" alloy and "super-duralumin," although these again are manufactured under a variety of trade names. Duralumin is quite commonly aged at room temperature, when excellent properties are obtained; artificial ageing can be used, with improvement in the yield point, but without increase in strength. Super-duralumin contains more silicon, and its improved strength is due to artificial ageing.

"Y" alloy differs from duralumin in that it contains more magnesium, while the manganese is omitted and replaced by 2 per cent. of nickel.

A comparison of the different wrought alloys shows that they are in many respects very similar, and the choice between them will be decided by the uses to which they are put. They all have the advantage that they can be worked in the soft condition, either in the annealed state when they are softest, or immediately after quenching, when they are all sufficiently soft to withstand considerable cold working. In the fully hardened state they can still be cold worked, but with greater difficulty. Where the greatest possible strength is required, duralumin has a definite advantage over the other alloys.

The simple magnesium-silicon alloys, though the weakest, possess the advantages of great softness at high temperatures and are very suitable for difficult forgings, such as crank cases and nose pieces for radial engines. They are also much softer than any of the other alloys in the annealed state, or immediately after quenching, and are therefore specially suitable for parts made by cold stamping and forming, and for thin-walled tubes of large diameter; on subsequent ageing they acquire a yield point little inferior to the other materials.

The copper-aluminium alloy is more readily worked hot than duralumin, and it is very suitable for high-grade forgings and stampings, such as air-screws. It is, however, inferior to duralumin and other strong alloys for severe cold forming or bending operations, and is less resistant to corrosion. It requires artificial ageing.

"Y" alloy is a little inferior in mechanical properties at ordinary temperatures to duralumin, but it is stiffer at high temperatures and not so easily forged and worked. It is specially valuable for use at elevated temperatures, since it maintains its strength under heat better than any other alloy. Forged pistons, connecting-rods, and cylinder heads are very suitably made in this alloy.

For unstressed parts cold-rolled aluminium sheet is much used.

Cast Aluminium Alloys.—It will be convenient to classify these alloys according to whether they are used as cast or in the heat-treated condition. In Table IV. are collected approximate compositions and properties of a number of the best or most commonly used of these alloys. The specific strengths are naturally not high in the "as-cast" condition, but heat-treated castings can be produced having very good properties.

TABLE IV.—*Approximate Compositions and Properties of Typical Aluminium Casting Alloys.*

Designation.	Composition, per cent. Cu.	Si.	Mg.	Zn.	Ni.	Fe.	Mn.	Specific gravity.	Sand castings. Ultimate tensile strength, tons/in.².	Elongation, per cent.	Brinell No.	Chill castings. Ultimate tensile strength, tons/in.².	Elongation, per cent.	Brinell No.
(a) Alloys Used Without Heat Treatment (Ageing).														
"L11" ..	5·0	—	—	—	—	—	—	2·86	8	0–1	60	10	1	60
"L8" ..	12·0	—	—	—	—	—	—	2·95	9	0–1	75	11	2	80
High silicon (modified)	—	11–14	—	—	—	—	—	2·6	11–12	2–5	55	13–14	5–11	65
Low silicon	—	5	—	—	—	—	—	2·65	8–9	3–7	—	8–9	3–7	—
"L5" ..	2·5	—	—	12·5	—	—	—	3·0	10–11	4	65	11–14	3–6	70
(b) Alloys Used in Heat-treated Condition (Quenched and Aged).														
"Y" alloy	4	—	1½	—	2	—	—	2·8	14–16	2–3	105	16–20	3–5	105
"No. 195" alloy ..	4–5	0·85	—	—	—	—	—	2·8	13 16–21	3–12 0–5	75–100 110	15 21	5·0 1·0	70 110
"No. 122" alloy ..	10	—	0·25	—	—	1·2	—	2·9	16	0–1	115	10–18	0·5	90–125
Lautal ..	4	3	—	—	—	—	—	2·76	*	*	*	16	4–6	70–90

* Not used for sand castings.

The use of aluminium die castings has extended greatly during recent years. They can be finished closely to dimensions, thus eliminating practically all machining, and holes can be placed with great accuracy, while they are cheaper than sand castings when produced in quantity. They will find an increasingly large application for lightly stressed parts as standardisation and output develop.

One of the most interesting applications of aluminium alloys is the piston of the aircraft engine. There is probably no other single item which has to satisfy such stringent requirements. The ideal piston alloy should have good mechanical properties at ordinary and elevated temperatures, a high thermal conductivity, a suitable thermal expansion, low specific gravity, and high melting point; it should be readily machinable and be capable of being cast in permanent moulds, have good bearing qualities in contact with the cylinder, a good resistance to wear, and a high degree of permanence of dimension. No one alloy is quite ideal, though some, as, for example, "Y" alloy, already competing on a volume basis with the heavier metal.

Magnesium is a metal with a great future, and it is a matter ior serious concern that we are dependent on foreign sources for our supplies, particularly as the ore is plentiful within the Empire.

One of the biggest advances in the technology of magnesium and its alloys has been the perfection of methods of melting and casting in the foundry. The metal is very reactive and combines vigorously with atmospheric oxygen at about 650 deg. Cent. or above, and with atmospheric nitrogen at a slightly higher temperature, and it really burns. Even when actual "burning" does not occur, oxides and nitrides become entangled with the molten metal when it is melted in contact with air. At higher temperatures silica is reduced, Mg_2Si being formed. By melting in wrought iron or mild steel vessels covered with a suitable flux, these difficulties have been overcome. Magnesium does not alloy with iron, and crucible failures always occur from the outside through scaling. The flux used is $MgCl_2$, with additions of other salts to reduce its fluidity, and decrease its tendency to dissociate. It not only protects the metal from contact with the air, but also dissolves any oxide or nitride that may be accidentally formed. It can readily be held back while the metal is cast. With reasonable care, by this process, clean metal can be delivered to the moulds with foundry losses of only 1 to 1½ per cent.

TABLE V.

Alloy.	Coefficient of expansion (20°–100° Cent.).
Copper-aluminium alloy (8–12 per cent.) ..	0·000025
"Y" alloy	0·000022
Aluminium-silicon alloy (12 per cent. Si) ..	0·000021
Aluminium-silicon alloy (24 per cent. Si) ..	0·000018
Magnesium	0·000026
Cast iron	0·000011
Austenitic iron	0·000017

Molten magnesium reacts violently with water, and for some years all sand castings were cast in dry moulds. The results, however, were not very satisfactory, even with moulds dried at 400 deg. Cent., largely owing to the difficulty of driving off the combined water in the clay bond, without destroying the binding power of the sand, and casting defects were common, while the process was costly.

TABLE VI.—*Approximate Compositions and Properties of Magnesium Alloys for Castings.*

Designation.	D.T.D. No.	Composition, per cent. Al.	Zn.	Cu.	Mn.	Si.	Mechanical properties. Ultimate tensile strength, tons/in.².	Elongation, per cent.	D.T.D. aircraft specification. Ultimate tensile strength, tons/in.².	Elongation, per cent.
Elektron AZ (sand castings)	59	4·0	3·0	0·3	0·35	0·3	—	—	12·0	6
Elektron VI. (die castings)	136	10·0	0·6	0·3	0·35	0·3	—	—	11·5	3
"AM 7·4" (sand castings)	—	7·0	—	—	0·4	—	10·5	6	—	—
"AM 7·4" (sand castings, heat-treated)	—	7·0	—	—	0·4	—	13·5–17	8–15	—	—

The number of elements that have so far been usefully alloyed with magnesium is small. Iron does not dissolve at all, while alloys with nickel, tin, and lead have not so far shown useful properties. Aluminium and zinc alloys have excellent casting qualities and physical properties, while being fairly resistant to atmospheric corrosion. Copper produces strong alloys, but greatly increases the corrosion under atmospheric conditions, and it is not a major constituent in magnesium alloys. Manganese has little effect on mechanical properties, but increases the resistance to corrosion, and about 0·3 per cent. is generally added. Silicon is also commonly present, and in satisfy many of these conditions. The most difficult is that of a suitable thermal expansion, since practically all aluminium alloys have a coefficient at least twice that of the cast iron or steel used for cylinder liners. Silicon lowers the expansion very considerably, and some alloys have been used containing high percentages of this element with additions of copper, nickel, and magnesium. The 13 per cent. alloy is too soft and wears badly; alloys containing still higher percentages have lower expansions and good resistance to wear, but they are weak and difficult to machine. They are about 50 per cent. more expansible than steel or cast iron. So far as expansions are concerned, a high silicon-aluminium alloy and a high nickel austenitic cast iron are very similar—see Table V.—both are likely to have good resistance to wear, and experiments with this combination for piston and cylinder would appear to be worth undertaking.

MAGNESIUM AND ITS ALLOYS.

Although magnesium has been isolated for over 120 years, serious attempts to produce the metal in substantial quantities were only commenced about twenty years ago. The price of the metal has fallen rapidly during the last few years, and I anticipate that, given sufficient output, it will be produced at least as cheaply per ton as its rival aluminium. Indeed, to-day, in spite of greater melting costs, magnesium alloy castings can be sold at about the same price as similar castings in aluminium alloys, and it is The problem has now been solved by the simple expedient of mixing a small proportion of sulphur together with a less quantity of boric acid, with ordinary moulding sand. The molten metal entering the mould instantly vaporises the sulphur in the surface layer, and the vapour appears to protect the metal entirely from reacting with the moisture in the sand; sound, clean castings are produced, and most of the sulphur condenses in the cooler parts of the mould, so that little is lost. Green sand moulds are used, which are preferably skin dried for large and important castings.

In other respects foundry practice is very similar to that required for aluminium alloys; the metal should be poured steadily in a constant stream; heavy sections require adequate feeding, and the use of heavy chills is often desirable.

sufficient quantity renders the alloys susceptible to hardening by heat treatment.

The mechanical properties of alloys suitable for castings are shown in Table VI.

By the methods I have described, magnesium alloy sand castings of high quality are being regularly produced. The foundry methods require careful control, but are quite suitable for large-scale production. Castings are not difficult to make, and they have the advantage that they are practically free from "pinholing," which is such a common source of trouble in aluminium foundries. It has, in fact, quite commonly been found easier to produce difficult castings in magnesium than in aluminium alloys. They are very suitable for the manufacture of pressure die castings, and are best cast in high-pressure machines, when very thin sections can be obtained. They have not proved to be so easy to cast by gravity die casting, and a number of technical difficulties have yet to be overcome, but there is no reason to believe that these will prove insuperable.

The development of wrought magnesium alloys is as yet so much in its infancy that I hesitate to say much about them. So far they consist essentially of aluminium-magnesium alloys containing up to 10 per cent. of aluminium and only small amounts of other elements.

Magnesium is not one of the easiest metals to work; it belongs to the hexagonal system, the crystals of which are liable to be brittle when stressed in certain directions, and considerable care is required in working. Sheet and extruded sections are being produced in considerable quantities and are finding many applications. Forgings are also being successfully produced, but there are still problems to be solved before complete success can be regarded as achieved in this direction. The working range of temperature is short—420 deg. to 450 deg. Cent.—and the working tools must be kept rather hotter than the work; slow working is best, and the press is preferable to the hammer, while the crystal structure is also of importance. A good deal of experimenting is going on at the present time, and there is no reason to suppose that the difficulties will not be overcome.

There are two directions in which magnesium is inferior to aluminium: its elastic modulus is less in about the same ratio as its specific gravity, and saving in weight is therefore sometimes only possible at the expense of rigidity. For many applications this is unimportant. On the other hand, in such instances magnesium alloy will often give greater strength for the same rigidity. The second disadvantage is in regard to corrosion: this is only serious in regard to sea water corrosion, and even in this instance has been much exaggerated. The present-day alloys are much better than their predecessors, partly because of better methods of manufacture, partly because of suitable alloying. The methods of working have also been found to have an influence, and further improvements may be expected when these are more developed. Moreover, methods of protection, such as have lately been devised for aluminium, by anodic oxidation, metallic coatings and varnishing will doubtless be devised also for magnesium alloys. The great corrodibility of steel in saline solutions has not prevented its use in seaplanes and protective measures are accepted here as a matter of course; the case of magnesium will doubtless be similar.

Research is needed in many directions. Theoretical and practical investigations are especially required on the deformation and working of magnesium, and on solid solubilities and the development of heat treatment—and the theory is not less important than the practice. When some of these problems have been solved, magnesium will be found to be a very serious competitor to aluminium, not only in aircraft, but also in automobile and many other branches of engineering.

BRITISH CHEMICAL STANDARD "BRONZE" (BRASS) "B."

THE fifth of the series of non-ferrous standard analysed samples is now ready for issue by British Chemical Standards, 3, Wilson-street, Middlesbrough.

The analysis is as follows:—

	Per cent.
Copper	58·8
Zinc	33·9
Manganese	1·03
Iron	0·94
Aluminium	1·62
Tin	1·76
Lead	0·78
Nickel	1·01
Arsenic	0·03
Antimony	0·05
	99·92

The composition is reasonably typical of that of some of the best grades of manganese bronze at present manufactured, and includes all the elements likely to be found in such an alloy.

Chemists experienced in the analysis of manganese bronze are well aware of the difficulties encountered, and though this standardisation was undertaken by analysts of repute, it was no light task to come to agreement on the composition. An important feature of the certificate of analyses which is issued with each bottle is the outline of the methods used by the different chemists.

The standard is available to anyone at a price based on ultimately covering the cost of preparing and issuing it. The three usual sizes, 50, 100 and 500 grm. bottles, are provided together with certificates just referred to.

THE BRITISH EMPIRE TRADE EXHIBITION, BUENOS AIRES.—A pamphlet giving the shipping instructions for the Buenos Aires Exhibition, March 14th to April 27th, 1931, has been issued by the Shipping Department, British Empire Trade Exhibition, Buenos Aires, 1931, 10–11, Finsbury-circus, London, E.C. 2 (Room 17, first floor). Telephone, Metropolitan 1429; telegrams, "Exhibition, Pehuaco." The address of the general offices of the Exhibition, to which all communications relating to matters other than shipping must be addressed, is the British Empire Trade Exhibition, 5, Parliament Mansions, Orchard-street, Victoria-street, London, S.W. 1. Telephone, Victoria 0877; telegrams, "Texbabem, Victoria, London."

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Trade Situation.

SPEAKING generally, industrial life in the Midlands and Staffordshire is dull, although spasmodic improvements are discernible in certain branches. There is no constancy about these advances, however, for a department which reports progress one week admits to slackness the next, and *vice versâ*. An all-round advancement before the end of this month is not now looked for with any degree of optimism. In these circumstances producers and consumers proceed with caution.

Steel.

The chaotic state of the foreign steel market naturally makes against settled conditions here, for consumers want to know just where they stand before placing orders, no matter how small. There has, undoubtedly, been a certain amount of speculative buying of foreign material, especially of half-products. Since it became known that an attempt was to be made to keep the cartel alive by forming separate cartels on the lines of the existing rolled wire or the steel rails cartels, foreign prices have steadied somewhat, and there are those who hold the opinion that prices have probably reached bottom. Since my last letter billets and sheet bars have been on offer at £4 15s. per ton, small steel bars at £5 5s., No. 3 iron at £5 7s. 6d. and strip at £6 5s. Prices continue to move erratically and are likely to do so, so that it does not follow that the figures given above are current at date. Indeed, at the time of writing small steel bars had recovered half-a-crown to £5 7s. 6d. This continental price war has caused a further falling off in business placed with native makers. British steel masters uphold recent prices, refusing to be moved by this stampede. They are sitting still, awaiting more settled conditions. Makers of heavy steel in Staffordshire report business as very slow. Constructional steel orders are small and scarce, while the increased demand for steel from motor engineering firms, which should be making itself felt by now, still hangs back. The Association prices for heavy steel are quoted as follows:—Angles, £8 7s. 6d.; tees, £9 7s. 6d.; joists, £8 10s.; ship, bridge and tank plates, £8 17s. 6d. Small bars are quoted £7 15s. upwards, and mild steel billets £5 15s. upwards, delivered.

Finished Iron.

There is no augmentation of activity in the finished iron industry in this area, neither are there signs which inspire confidence in the future. Particularly does that remark apply to the common bar branch, in which competition has been intensified by the collapse of foreign price control. Some slight invigoration in the Crown bar department has been noticed during the past week or so, but it is not such as to rouse confidence. Internal competition in that branch of the iron trade makes it difficult for the Staffordshire ironmaster, whose selling price is higher than that of makers in other districts, to secure business. Fortunately, there are users who place such reliance upon Staffordshire Crown bars that they do not hesitate to pay the higher purchase figure. Though efforts continue to be made by makers to keep the price up to £10 7s. 6d. per ton actual transactions are put through at prices varying between £10 and £10 7s. 6d. Marked bars sell steadily and values are unchanged at £12 10s. per ton. Regular working at the mills is made possible by small orders coming to hand in a steady flow week by week. There is always a certain limited demand for this high-class engineering iron. Makers of nut and bolt and fencing bars continue to quote £9 per ton for their product, although competing material in the shape of Belgian No. 3 iron is this week offered at £5 7s. 6d. per ton delivered, or 5s. per ton below recent acceptable rates. It is obvious that local makers cannot expect to secure many orders against such competition. Iron tube strip is in fairly good demand at £11 2s. 6d. per ton. Trade is not so good as it was, however, in this department.

Pig Iron.

In the pig iron market the hand-to-mouth policy of buying is persisted in, and the most favourable thing which can be said is that tonnages are in advance of recent specifications. That applies alike to merchants and consuming customers. It may be that at the quarterly meeting of the iron trade next month forgemen and foundrymen may consider it worth while entering into forward contracts. Blast-furnacemen appear to have little anticipation of this class of business during the current month. Present restricted production is in excess of consumptive requirements and stocks continue to grow. With the approach of the winter demand for fuel, coke prices show a tendency to harden. Smelters are not prepared, at any rate as yet, to pay the 13s. a ton at ovens now mentioned by some sellers. Business can, of course, be done to-day at below that figure. Raw iron prices show no variation from the basis as fixed by the Producers' Association. Derbyshire and North Staffordshire No. 3 foundry iron is £3 13s. 6d.; forge, £3 8s. 6d., while Northamptonshire foundry commands £3 10s. and forge £3 5s.

Galvanised Sheets.

Local galvanised sheet mills, chiefly as a result of orders received from consumers in this country, continue regular rolling. Overseas demand, though slightly better, remains much below what it should be at this time of the year. Neither in the heavy nor in the lighter departments is business satisfactory. Makers maintain their selling rates on the basis of £11 17s. 6d. per ton for 24-gauge corrugateds. The improvement in the black sheet branch is upheld, but progress is slow. Values are unchanged.

Tinned Sheets.

Tinned and lead-coated sheets sell moderately well at recent price levels, viz., charcoal, 44s.; best charcoal, 50s.; extra best, 52s.; lead-coated, 20s.; tin-terne plates, 23s., all per hundredweight to 20 gauge basis, delivered.

Scrap.

There has been no development in buying of heavy steel scrap from this district consequent upon last week's inquiries. Prices are still indeterminate. The restarting of some works in South Wales is looked upon as providing prospects for increased sales of scrap in the near future.

Rail Car Contract.

The Sentinel Wagon Works, Ltd., of Shrewsbury and Westminster, has received from the Tasmanian Government Railways an order for two 100 H.P. "Sentinel Cammell" steam rail cars. Each is to have accommodation for forty-five passengers. The same firm has also received an order for three 100 H.P. "Sentinel" locomotives for India.

Motor Engineering.

There are definite signs of increased activity in the automobile engineering industry in Coventry, Birmingham and Wolverhampton. Subsidiary trades are beginning to receive inquiries and orders and manufacturers of gear-boxes, engines, frames, pressings, steel tubes and other component parts are now moderately employed. Orders for special steels are also the subject of negotiation. The programmes announced by several of the leading motor engineering firms lead to the hope of a possible development, which may compensate all connected with the industry for the past disappointing season.

Unemployment

Although continued decreases in the number of unemployed were recorded last week at most of the large industrial centres in the Midlands, increases in a large number of smaller towns turned the scales towards the gloomy side, the grand total for the Midlands area being in advance of last week's figure by 1878. Birmingham workshops are steadily engaging additional hands, the same remark applies to Leicester, Stoke-on-Trent area and Wolverhampton. At Coventry and Nottingham the figures continue to advance, as is the case in the following Black Country towns:—Cradley Heath, Dudley, Smethwick, Stourbridge and Brierley Hill, Tipton, Walsall, Wednesbury and West Bromwich. Of the total unemployed, 194,886 are male adults and 82,622 are women.

Obituary.

It is with regret that I have to record the death, on Sunday last, at the age of 71 years, of Mr. W. J. Bridgwater, of Dudley. Mr. Bridgwater, who was for many years a member of the Birmingham Iron and Steel Exchange, was the principal of the firm of W. J. Bridgwater and Co., iron and steel merchants, Castle Hill, Dudley.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

Blackburn's Economy Campaign.

AN interim report of a special committee which was appointed to inquire into the organisation and management of the electricity department of the Corporation has been presented to and adopted by Blackburn Town Council. The inquiry was dictated by the heavy losses which the department has sustained during the past ten years, and by the high charges which consumers in the borough have to pay for current. As a preliminary attempt to establish some measure of equilibrium, the committee decided to recommend a drastic reduction of staff, about twenty employees, including the chief assistant engineer, being affected. That step will result in a substantial saving in salaries and wages, and further economies are involved in recommendations which aim at the reduction of overtime working, the discontinuance of the supply of cookers and other electrical apparatus on hire terms, and the closing down of the department's showroom. Obsolete plant and machinery is to be disposed of, and material of various kinds which is regarded as useless for maintenance and new capital works is to be depreciated as fully as possible so as to bring it more into line with real values.

More Motor Omnibus Orders.

Two Lancashire firms have benefited substantially during the past week by orders for motor omnibuses. The tender of Leyland Motors, Ltd., of Leyland, near Preston, for ten double-deck vehicles and twenty chassis at a total cost of £35,480, has been accepted by Wigan Town Council, and an Aberdeen order for fifteen double-deck omnibuses has been placed with Crossley Motors, Ltd., Gorton, Manchester.

Industrial Results.

The report of Kendall and Gent, Ltd., machine tool makers, of Gorton, Manchester, for the past financial year states that in spite of widespread depression in industry in the home market and adverse economic conditions in overseas markets, a trading profit of £3317 has been made, which compares with £5190 a year ago. The net profit, however, is only £110 after providing for debenture and loan interests and certain depreciation. In the previous year the net profit was £2006, whilst in 1927–28 a loss of £539 was sustained. A decline in the profits of Arundel, Coulthard and Co., Ltd., textile machinery manufacturers, of Stockport and Preston, has resulted in the dividend on the ordinary shares for the financial year ended June 30th being passed. Except in 1925–26, this is the first time no distribution has been made since the company was established ten years ago, the dividends having ranged from 5 to 10 per cent.

A Liverpool Appointment.

Liverpool City Council has decided to advertise the vacant position of city engineer and surveyor at a salary of £2000 a year.

Non-ferrous Metals.

If conditions from the point of view of prices have been steady in most sections of the market for non-ferrous metals during the past week there has been no noticeable development of the demand. In view of the attempts to curtail production, the tendency at the moment in respect of tin is to take a somewhat more cheerful view of the statistical outlook for the near future, and, it is largely upon the strength of that, that market values since last report have been so unusually steady. Actual buying of the metal during the past week can at the best be described only as moderate. This, also, is the case with regard to copper, although a certain amount of interest has been displayed in forward deliveries of standard metal. Sales of refined descriptions continue very quiet. On balance there has been virtually no change in price levels. As before, lead continues to be relatively favourably placed from a statistical point of view, and little difficulty has been experienced in maintaining quotations for the metal. A fair demand has been experienced, and very few weak sellers have been in evidence. Spelter has been the only section this week to lose ground, although even with it the decline has been only to the extent of a shilling or two. Buying, however, has been slow, and in spite of curtailed production, supplies are ample.

Iron and Steel.

Mixed conditions have ruled this week on the market for iron and steel. The demand for foundry iron has been rather better than of late, although there is no disposition, except in a few rare instances, to buy forward to the extent that was general about a year ago. Foundry trade conditions, however, are a shade brighter on the whole, and that has resulted in near-delivery orders for small parcels being more numerous. With regard to prices, Derbyshire and Staffordshire pig iron is quoted at 72s. per ton, forge at 67s., Scottish at 93s., and West Coast hematite at 87s., including delivery equal to Manchester in each case. Bar iron is steady at £10 5s. for Lancashire Crown material and £8 15s. for No. 2, but buying shows no improvement. Constructional engineers at the moment are dealing with a few more inquiries, but so far they have not started to specify for bigger quantities of steel, whilst the new orders they are placing just now are poor. Locomotive builders, boilermakers, and textile machinists are also affording relatively little support to the market. Small re-rolled bars are weaker at £7 15s. to £7 17s. 6d. per ton, but otherwise prices have been maintained. The very cheap offers of continental steel materials seem to have attracted more business during the past week. Imported billets and sheet bars are now obtainable here at down to £4 10s. per ton, delivered equal to Manchester, with finished products at correspondingly low rates.

BARROW-IN-FURNESS.

Hematites.

Business in West Coast hematite pig iron remains quiet all round, and there are no signs of any material improvement. Trading for some time has been from hand to mouth, buyers being content to place orders to tide them over their immediate wants and no more. Requirements on general home account are moderate, and the closing down of the steel plant at Workington has eased the local call for iron. Barrow steel makers are still out of the market. There is not much being done on continental account, but a shipment has been made from Barrow docks to Hamburg. More iron is being made than can be found a sale for, and metal stocks are going up. The make is being curtailed.

Iron Ore.

There is a quiet demand for hematite iron ore, the trade done being largely on local account, with some best grade ore going to Scotland and the East Coast. Foreign importations of ore are quiet at present.

Steel.

The position in the steel trade is depressed. The plant at Barrow has been idle since July on account of the shortage of orders, and now the Workington Steel Works have ceased to operate, trade being so bad. For rails, the chief product there, there are no offers, while billets are in the background. Hoops are being rolled at Barrow, the demand being fair. Steel billets are also being imported from Belgium.

Shipbuilding and Engineering.

There is a fair amount of activity in the shipbuilding and engineering industries, but no new orders are to hand.

Fuel.

There is a steady demand for steam coal, and coke finds a ready sale, both Cumberland and Durham sorts.

SHEFFIELD.

(From our own Correspondent.)

Steel Production in July.

RETURNS have now been published of the production of steel ingots and castings during July, and the Sheffield area makes a rather better showing than might have been expected, in view of the paucity of new business that has been coming forward for some time. The total production during the month was 82,200 tons, including 32,200 tons of acid and 40,500 tons of basic material. That was a considerable improvement on the June figure, which was only 65,200 tons. It was, however, much below the standard of July, 1929, when the output amounted to 97,300 tons. Whether the August figure, when it comes to be published, will equal that of July, remains to be seen, but I should imagine that it is doubtful. For many weeks now there has been no variation in the story of hand-to-mouth bookings, and complete lack of tonnage orders, while the number of furnaces in commission has only been from a quarter to one-third of the total available. The output at present is on a rather less scale than before the holiday suspension, and there is no definite evidence of a stronger demand. Inquiries are perhaps a little more numerous, but they are not coming along on the usual September scale. At the same time, a feeling of confidence is growing, and, while no upward movement is expected this month, it is thought that October may see some revival.

In Lincolnshire.

The Lincolnshire output of steel during July compared very favourably not only with June but also with July of 1929, the most recent figure being 63,200 tons, as against 34,400 one month before and 34,500 twelve months previously. The output of pig iron, however, showed a drop, being 59,100 tons, which was 9000 tons less than in June and 22,000 tons less than in July, 1929. Scarcely any foundry pig iron is being made in Lincolnshire at present, but the steel outlook appears to be improving. The Frodingham Iron and Steel Company, Ltd., which stopped five big furnaces six months ago, has now restarted two of them. At the other works in that district, the position is much the same as it was before the August holiday.

A General Review.

There is no movement of note in the iron and steel market. While a rather better call for pig iron is reported from some districts, trade, locally, consists almost entirely of the buying of odd lots to cover current consumption. A continued shrinkage of work is reported by the ordinary rolling mills and forges. In specialities there is more being done. The requirements of the automobile industry represent a valuable amount of trade, though it is below its normal volume. There is a substantial amount of activity in stainless and heat-resisting steels. For cold rolled steel and strip the demand showed a notable falling off some months ago, but it is now picking up again, although conditions are still very quiet. Certain classes of alloy steel are attracting more interest than they have done for a considerable time.

Orders for Tires.

The departments producing railway axles, tires, and springs are badly off for work. The home railway companies are still pursuing a policy of strict economy, and work for overseas is on an unsatisfactory scale. Some orders for tires have, however, been reported during the past week. The Union of South Africa Railways has distributed, among British and continental manufacturers, orders for a total of 14,617 steel tires for locomotives, carriages and wagons. Of them, 2886 are to be supplied by Steel, Peech and Tozer, Ltd., Sheffield, and 589 by Brown Bayley's Steel Works, Ltd., Sheffield. Another share of the work coming to this district is the making of 908 tires by the Monk Bridge Iron and Steel Company, Ltd., of Leeds, which have had several other orders from the South African Government this year. It is notable that, while other orders for tires have been placed in this country, the largest individual one—for 4400 tires—has been placed in Germany, with the Vereinigte Stahlwerk Bochumer Verein, of Bochum, while 540 have been ordered from the Skoda Works, Prague.

The Lighter Trades.

The light castings foundries are not by any means well supplied with work. There is a fair inquiry for certain kinds of tools, but the progress of the autumn season is not accompanied by any corresponding increase in demand. There has been much depression in the file trade throughout the year, and prospects do not indicate any early improvement. The demand for ordinary saws is irregular, but hacksaws are a fairly good market. While the electroplate and cutlery industries are not satisfactorily employed, orders are coming to hand rather more freely, and it is thought that the corner of the depression has been turned. There are some good orders on hand for coupon and gift goods, including one for 10,000 pewter drinking mugs. Ordinary home trade remains quiet. There is growing apprehension of the consequences which will follow the lapsing of the safeguarding on cutlery in December. A great increase of German competition is anticipated, and it is reported that the cutlery firms in Solingen have huge stocks on hand ready to be shipped to this county when the duty expires. Hitherto, the Germans have not sold a great deal of table cutlery over here, but they have been producing more attractive patterns, and it is expected that stainless steel table knives will be among the increased exports from that country, while other branches affected will be pen and pocket knives and scissors. The penknife trade is already suffering to some extent from the fashion for propelling pencils, and altogether the outlook is not bright. There are at the moment about 2000 unemployed in the Sheffield cutlery trade, and it is feared that their ranks will be considerably augmented before long.

Cement from Ironworks Slag.

The enterprise of making cement from pig iron slag is to be introduced into Leeds by the Leeds Steel Works. The works have already produced cement which has been fully up to the requirements of the Brtish standard specification, and now it is intended to install plant for manufacturing the cement in conjunction with the pig iron process. The iron ore used at Leeds comes from Lincolnshire, and its chemical composition is said to give it intrinsic cementatious properties.

A Big Cleethorpes Scheme.

An improvement which has cost no less than £120,000 has just been completed at Cleethorpes in the shape of a sea wall and embankment over a mile long at the Humberston extremity of the foreshore. It has been carried out with financial assistance from the Unemployment Grants Committee, to the designs of Mr. Leonard Pye, engineer and surveyor to the Cleethorpes Urban District Council, and for sixteen months has afforded employment for nearly 200 men, including many miners from distressed areas. Along the embankment is a macadam walk, 12ft. wide, and over the Buck beck is a concrete bridge with tidal sluice gates. The scheme will make for more efficient draining in the vicinity, in addition to preventing tidal flooding of certain low-lying land. It also makes possible the reclamation of over 100 acres of waste foreshore, which will be available eventually for recreation, and probably as a site for an aerodrome.

The Discovery of Concealed Metals.

A good deal of attention has been attracted by an apparatus by means of which underground metals are indicated from the surface, which is a recent invention of Drs. Franklin and Chapman, principals of schools at Matlock. Dr. Chapman, in an interview, stated that they had been successful in tracing deposits of ironstone in Cumberland. They have also just completed a survey for hematite, and have found deposits where none were known to exist. The apparatus has also been tested in the Chesterfield district, near where oil wells were drilled at Hardstoft some years ago, and oil has been indicated. Dr. Chapman further intimates that there will shortly be an important development in the lead-bearing areas of Derbyshire.

New Lightship for the Humber.

The Humber Conservancy Board is about to install a specially-designed light float on the Humber service, and the order for the building of the vessel has been placed with Richard Dunston, Ltd., of Thorne. The acetylene lantern and flashing apparatus is to be carried on the top of a steel superstructure constructed amidships. The fog signal is to be a bell, having four bell tongues, three of which are to be suspended by links and tolled by the motion of the vessel, and one operated by means of a paddle wheel, bevel gear and cam, situated in the centre of the vessel amidships. A waterway tunnel is to be carried longitudinally through the vessel for the purpose of driving the apparatus. An additional fog signal, consisting of an electric horn, timing clockwork and batteries, is also to be supplied and fitted.

NORTH OF ENGLAND.

(From our own Correspondent.)

Tees Dock Improvements.

A COMPREHENSIVE scheme, estimated to cost £200,000, for the improvement of the crane equipment at the Middlesbrough Dock, has been drawn up by the L.N.E.R. Company, and it is expected that the work will be put in hand at the end of this month. The new cranes will have double the handling speed of the present equipment and greatly increased lifting power. The improvement suggests an alternative, to an extent, to the provision of new docks on the Tees, and as a means of reducing the risks of congestion, it is the determination of the railway company to have the Middlesbrough Docks as modern in character as possible. The news of the development has been received with satisfaction by shipowners and shipbrokers. Thirty-nine of the 42 cranes at present in operation, viz., twenty-six 3-ton, four 5-ton, and nine 10-ton with fixed jibs of the 44ft. 9in. radius, are to be replaced by new electrically-driven two-gear cranes for working at half their maximum capacities. Seven additional 3-ton cranes of the same type will be provided.

Cleveland Iron Trade.

The position in the Cleveland pig iron trade shows little improvement on the week. A few orders have been released, but the volume of business being done is still on a very disappointing scale. The limited output of iron is ample for present needs, but quantities stored at makers' yards are not of inconvenient dimensions, and additions to stocks are hardly likely to continue. Most of the production is still used in its molten state at ironmasters' own foundries and steel works. The surplus that is converted into pig for the market is almost taken up by local and other home users who have to buy their iron. Sales to firms abroad are few and small, and there is little prospect of early material expansion of export trade. Second hands are not in a position to offer much Cleveland iron. Midland and continental iron continues to be used to some extent on Teesside. Prices are unchanged, No. 1 Cleveland foundry iron being 66s., No. 3 G.M.B. 63s. 6d., No. 4 foundry 62s. 6d., and No. 4 forge 62s.

Hematite Pig Iron.

Producers of East Coast hematite pig iron are hampered by heavy stocks, but a change for the better may soon occur in the unsatisfactory statistical position, as customers with orders to fill hope to accept arrears of delivery more freely in the near future. Recent sales include parcels for destinations abroad, but as continental competition continues keen for overseas trade, recovery of lost foreign markets threatens to be very slow. Makers of East Coast brands are unwilling to give price concessions, and keep quotations at the equivalent of ordinary qualities at 71s., though merchants are accepting rather less and still have substantial holdings they wish to dispose of.

Ironmaking Materials.

There is little new in the foreign ore trade. Business is still confined to narrow limits, consumers being well placed as regards supplies and not at all disposed to enter into new contracts; but, with freights inclined to stiffen, quotations are well maintained. Best Rubio ore is 19s. c.i.f. Tees. Prompt parcels of blast-furnace coke of good average quality remain at 16s. 6d. delivered

at North-East Coast works, but up to 17s. 6d. is asked for forward supply.

Manufactured Iron and Steel.

New business in the various manufactured iron and steel departments matures slowly, but customers are somewhat less disinclined to discuss provision for needs over periods ahead, and a few contracts have been secured. Inquiries are reported for railway material, constructional steel and sheets, but demand for certain other commodities is still very quiet. Quotations are steadily upheld.

Shipbuilding Outlook.

Shipbuilding output on the North-East Coast is easily outstripping new work received, and the prospect for the winter months is none too bright, as by that time a considerable volume of the work now in hand will have been completed. Some of the yards are getting very low in work, and there is almost an entire absence of new orders. Swan, Hunter & Wigham Richardson, Ltd., Wallsend, have booked an order for two large motor tankers for Norwegian owners, with Wallsend Slipway Engineering Company's engines, which is a welcome addition to the order for the New Zealand floating dock received a few weeks ago. The inquiries for new vessels are limited, and do not include ordinary cargo vessels. A few foreign inquiries are circulating, chiefly for tankers, but they are small in number in proportion to the work urgently needed.

Coal Marketing Schemes.

In compliance with the requirements of the new Mines Act, the Northumberland and Durham colliery owners have completed their respective draft marketing schemes, and submitted them to the Board of Trade for approval. In these schemes, there is no indication of minimum prices or quotas of production, which are matters to be decided after the formal schemes are confirmed. It may, therefore, be a few weeks before the new prices are known. They represent the crux of the position so far as export is concerned, and will call for careful consideration. To the foreign consumer the deciding factor will be the world price of coal rather than any particular marketing scheme. Some important tendering is due during the next few weeks, and where delivery is well into next year there must be a considerable element of speculation as the forthcoming minimum prices may change the situation very appreciably.

The Coal Trade.

There is no feature of moment in the Northern coal market. Foreign buyers appear to show no interest in the position for the next few weeks. While sounding the market for the last month or two of the year, they are not inclined to commit themselves. The coal mines marketing scheme is, to an extent, holding up forward trade, but although the owners generally anticipate that the scheme will cause higher prices, it is doubtful if definite November business would be turned down at the current prices. Even under curtailment of output the pits are finding difficulty in clearing off the available stocks. For gas coals neither home nor export demand shows any improvement. Best qualities are quoted at 15s., and secondary at 12s. 6d. to 12s. 9d. Coking unscreened is in excessive supply at 12s. 6d. to 13s. For bunker classes the first grade stands at 13s. 6d. to 13s. 9d., and good ordinary at 12s. 6d. to 12s. 9d. Northumberland steams are quiet, but there is not a heavy surplus of smalls owing to the restricted output of other classes. Best steams are at 13s. 6d., and seconds at 12s. The coke trade outlook is fairly good, but new business matures slowly. Gas coke is in sustained demand, and if foundry and blast-furnace cokes are easy for prompt, they are developing strength for delivery later on. The winter price is quite 6d. a ton above what is being asked at the present time. Gas coke is 21s. 6d., patent oven 17s. to 18s., and beehive and superior foundry qualities steady at 24s. to 28s.

SCOTLAND.

(From our own Correspondent.)

Conditions Dull and Depressed.

THE industrial position on the whole displays nothing of fresh interest or any encouraging sign that the depression which has characterised markets for a considerable time past will soon be relieved to a sufficient extent to engender hope for the near future. At the moment the outlook for the winter months is dull in the extreme.

Steel.

The demand for steel products with few exceptions is on a restricted basis, and a good deal of idle time at the works is inevitable. Heavy steel is especially disappointing, in view of anticipated demands for shipbuilding materials, which have not materialised. Ship plates, boiler plates and sections could all easily overtake a greatly increased demand, few producers, if any, being fortunate enough to see more than a few days ahead.

Tubes.

Tubes of the larger descriptions are comparatively well specified, but small sized tubes, especially those of the butt-welded variety, are suffering from a lack of Indian, Australian, and South American demands.

Sheets.

Sheets likewise are irregular. Light sheets have steady demands, but heavy black and galvanised descriptions are quiet. In the case of heavy black sheets, producers suffer in competition with steel makers.

Iron.

Nothing has occurred during the week to lessen the depression in the wrought iron and re-rolled steel bars industry. The former remain unchanged in price, but though concessions might be granted in quotations for the latter, prices would be still far in excess of the continental figure for competitive material. Re-rolled steel bars are nominally £7 12s. 6d. per ton home or export. The latest reduction in the price of hematite pig iron has not resulted in an increased turnover so far. Few furnaces are in blast, but outputs are sufficient.

Scrap.

Scrap materials change hands in small quantities, with heavy steel quoted about 52s. 6d. and cast iron machinery 62s. 6d. per ton.

Coal.

There is little change in the coal trade. Both home and export markets remain dull. Large fuel, with the exception of Lanarkshire best splints and ells, lack export demands, the shipping inquiry being on a restricted day-to-day principle, neither collieries nor shippers being disposed to consider commitments beyond early October. All sizes of nuts are firm and move off freely. Aggregate shipments amounted to 256,285 tons, against 223,804 tons in the preceding week and 310,157 tons in the same week last year.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

The Coal Trade.

THERE seems to be a little more movement, and yet there is no perceptible effect upon steam coals, so far as prices go. In fact, a good deal more business is required to make collieries busy, and there must be considerably more chartering of tonnage to keep the docks well engaged. At the same time, the docks position has been slightly better. At the end of last week the number of idle tipping appliances was twenty-seven, and there were three steamers waiting to load, while on Monday last the number of idle tipping appliances was reduced to nineteen. Shipments last week, according to the returns of the Great Western Railway Company, amounted to 529,100 tons, which compared with 540,300 tons in the preceding week and with 551,931 tons for the corresponding period of last year. Conditions would be better for the collieries if tonnage for some directions were more readily forthcoming. The tone of the outward freight market is steadier, but, still, business is not so active as materially to benefit freight rates. A rise in freight rates is certainly more feared in some trades than is an advance in coal prices, for the reason that continental competition is so keen, and foreign producers have such a surplus of coals to find an outlet for, that if Welsh prices for coals are advanced, it is difficult to see how coalowners will be able to find a market for them. An illustration of this state of affairs has been forthcoming since writing a week ago. The Brazilian Central Railways, which in the past have consistently bought their requirements from this district, asked for prices for 200,000 tons of coals for delivery at Rio de Janeiro over the next six months. Despite the fact that very low prices were submitted from South Wales, the news has come to hand that German mineowners undercut to the extent of 2s. per ton. It is not yet definite that the railways have placed their order with the Germans, as the tenders have to hold good for a time, but it is not unlikely that the whole of the business will go to Germany, unless the Brazilian Railways consider that it would be wise to place a part of their requirements with South Wales, in case the German coals do not give entire satisfaction. Still, this instance of the severe competition that has to be faced causes no little uneasiness, in view of the prospect of the costs of production in South Wales being increased as the result of recent legislation, while the tendency on the Continent is to secure a reduction of their costs by lowering wages.

Weighing and Tipping Charges.

Satisfactory news was forthcoming for colliery owners in this district last week when the announcement was made that the Ministry of Transport had issued an order that the tonnage charge for tipping coal, inclusive of weighing at the docks owned by the Great Western Railway Company—excluding Swansea—is to be 5½d. per ton as and from October 2nd. That means that the Great Western Railway Company lost its case when it recently applied for an increase, while the traders won their case for a reduction in the existing charge. The charge has been 6d. per ton since October 2nd, 1929, that figure being a reduction of 1½d. per ton upon what was previously in operation. That saving of 1½d. per ton represented on a shipment of 29,000,000 tons per annum £151,000, while the further reduction now of ½d. per ton on the same tonnage is equivalent to another £60,000, making a total annual saving to the colliery owners of £211,000. The reduced charge is to operate for a period of twelve months. It should be pointed out that under an arrangement with the Great Western Railway Company the charge of 5½d. will operate at the Swansea docks as from October 2nd.

Coal Marketing Scheme and Wages Agreement.

The official announcement is made that the Executive Committee of the South Wales Coal Marketing Association, including representatives of the minority owners, has completed the scheme to be submitted to the Board of Trade for the regulation of output and for the fixing of minimum prices under Part I. of the Coal Mines Act, 1930. At the same time, all the colliery owners in this district are being informed that, if practicable, the output of the district will be regulated as from November 1st next, and that it will involve the regulation of the output of every owner. Members of the South Wales Coal Conciliation Board met on Monday last when the owners' representatives, after expressing their views on the operation of the new Coal Mines Act as concerns working hours, intimated their intention of tabulating their proposals for submission to a further meeting of the Board in September. Thus the fringe of negotiations has been touched regarding a new agreement with the men, whose representatives will doubtless have certain proposals to put forward when the time comes.

North Wales Coal Audit.

In the case of the North Wales coal industry, the independent accountants report for the three months ended July shows a debit balance of nearly £7782, equal to 2·32d. per ton on an output of 803,646 tons. The proceeds amounted to £508.397, or 12s. 7·83d. per ton, and the cost of production £516,179, or 12s. 10·15d. per ton. The wage certified by the auditors was equivalent to 99·81 per cent. of the basis rates, but the agreement provides for a minimum of 22 per cent. above the basis rates, and the deficiency due to the payment of the minimum was £77,715, thus increasing the total deficiency carried forward to £3,366,864.

Steel Works.

The re-employment of labour at the Dowlais Steel Works, Merthyr, which reopened on Monday in last week after a stoppage of several weeks, has made steady progress, and it is reported that 2300 men are at work and a second blast-furnace was started on Thursday in last week. In the case of the Briton Ferry Steel Works, Briton Ferry, notices were posted up on Wednesday in last week that the works would close down at the end of this month, in consequence of the depression in trade. About 300 men are employed. The Old Castle Tin-plate Company, of Llanelly, is reported to have embarked upon a scheme for the modernisation of its plant, at the cost of thousands of pounds. The first stage of the scheme involves the equipment of the finishing department on the most up-to-date lines. Existing machinery is to be scrapped and is to be replaced by new continuous annealing furnaces and 10-ton overhead gantry cranes are being provided. The remaining part of the scheme provides for the reorganisation of the mills. The new finishing department will be housed in a lofty building, 300ft. long by 90ft. wide, and the new plant will, it is estimated, be capable of dealing with 12,000 boxes per week. Five obsolete annealing furnaces have been dismantled. It is expected that the developments in progress will take six months to complete. Whilst in progress, six mills will be operated.

Current Business.

To all outward appearances there has been no alteration in the steam coal market during the past week. In all branches prices remain at the minima, and buyers have no difficulty in satisfying their requirements, except perhaps in a few isolated cases. The demand for patent fuel and coke is quiet and pitwood is depressed, prices being round about 26s. to 26s. 6d.

CONTRACTS.

JAMES AND FREDK. HOWARD, Ltd., of Bedford, have received an order to supply their equipment for the new abattoir of the municipality of Buluwayo.

THE BRITISH THOMSON-HOUSTON COMPANY, Ltd., has secured an eighteen months' contract from the War Office for the supply of vacuum, gas-filled and carbon filament "Mazda" lamps.

THE COMBUSTION ENGINEERING CORPORATION has received an order from the Solvay Process Company, New York, for a combustion steam generator. The boiler is to have a heating surface of 15,671 square feet and is to be fired by two unit mills with tangential burners. The flue gas heat extraction equipment is to comprise a twin-plate type air heater.

THE MARCONI INTERNATIONAL MARINE COMMUNICATION COMPANY, Ltd., has entered into a contract to install and operate nine wireless installations, complete with direction finders, on new vessels of the British Tanker Company's fleet. These installations will comprise ½-kW valve wireless transmitters; valve receivers covering a wave-range extending from the short wave-lengths which have now come into commercial use to the very long wave-lengths used by the Post Office station at Rugby; and also the latest type of Marconi direction finder. An emergency spark transmitter which is totally enclosed in a gas-tight container will be included in each installation and will be provided with power from a small motor alternator driven by a 24-volt accumulator battery.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

MR. ARTHUR HENRY STOCKLEY, who is vice-chairman of Elders and Fyffes, Ltd., and Fyffes, Ltd., has joined the board of Cammell Laird and Co., Ltd., Birkenhead.

THE SELSON ENGINEERING COMPANY, Ltd., of 26–28, Charles-street, Hatton-garden, London, E.C. 1, asks us to announce that it has been appointed sole agent for the Bilgram Machine Company for its bevel gear planing machines.

PHILLIPS AND SONS (CHISWICK), Ltd., of 42, Waterford-road, Walham Green, London, S.W. 6, ask us to announce that Mr. A. E. Halliwell has resigned from the directorate and has now no interest in or connection with the company.

BRITISH ROPES, Ltd., asks us to announce that, as from September 15th, 1930, its head office will be moved from 32, Cavendish-square, to 52, High Holborn, London, W.C. 1. Telephone, Chancery 8822 (ten lines); telegrams, "Britrope, London."

MAJOR THOMAS E. ROBERTSON, A.M.I.E.E., A.F.R.Ae.S., chartered patent agent, will, on September 19th, 1930, remove his offices from Hazlitt House, Southampton-buildings, W.C. 2, to High Holborn House, 52–54, High Holborn, London, W.C. 1. Telephone, Chancery 7817.

MOSERS LTD., of 4, Marshalsea-road, and Borough High-street, London, S.E. 1, asks us to announce that it has concluded an arrangement with Messrs. R. and J. Rankin, of Liverpool, to act as sole distributing agent for the "Johnston" patented wrench for London and the South of England.

VICKERS LTD. ask us to announce that Colonel J. B. Neilson, C.M.G., D.S.O., C.A., has been appointed director and deputy chairman of the company in place of the late Mr. G. G. Sim, C.S.I., C.I.E., and that although Colonel Neilson retains his appointment as deputy chairman of Baldwins Ltd., that does not imply there is any connection or working arrangement between the two companies.

THE HORSELEY BRIDGE AND ENGINEERING COMPANY, Ltd., THOMAS PIGGOTT AND CO., Ltd., GUEST, KEEN AND PIGGOTTS, Ltd., of Horseley House, 85, Lionel-street, Birmingham, ask us to announce that on Monday, September 15th, their London office will be moved to 22, Carlisle-place, Victoria-street, S.W. 1. Telephone number, 3836 Victoria, London; telegrams, "Galileo, Sowest, London (Horseley);" "Intersection, Sowest, London (Piggotts)."

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
(1) Native	17/9 to 20/6
(1) Spanish	20/6 to 21/–
N.E. COAST—	
Native	18/– to 21/–
Foreign (c.i.f.)	19/–

PIG IRON.

	Home. £ s. d.	Export £ s. d.
(2) SCOTLAND—		
Hematite	3 18 6	—
No. 1 Foundry	3 19 0	—
No. 3 Foundry	3 16 6	—
N.E. COAST—		
Hematite Mixed Nos.	3 11 0	3 11 0
No. 1	3 11 6	3 11 6
Cleveland—		
No. 1	3 6 0	3 6 0
Siliceous Iron	3 6 0	3 6 0
No. 3 G.M.B.	3 3 6	3 3 6
No. 4 Foundry	3 2 6	3 2 6
No. 4 Forge	3 2 0	3 2 0
Mottled	3 1 6	3 1 6
White	3 1 6	3 1 6
MIDLANDS—		
(e) Staffs.—	(*Delivered to Station.*)	
All-mine (Cold Blast)	—	—
North Staffs. Forge	3 8 6	—
„ „ Foundry	3 13 6	—
(e) Northampton—		
Foundry No. 3	3 10 0	—
Forge	3 5 0	—
Derbyshire—		
No. 3 Foundry	3 13 6	—
Forge	3 8 6	—
(3) Lincolnshire—		
No. 3 Foundry	—	—
No. 4 Forge	—	—
Basic	—	—
(4) N.W. COAST—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 3 6 (*a*)	—
	4 6 6 (*b*)	—
	4 10 6 (*c*)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	10 5 0	9 15 0
Best	—	—
N.E. COAST—		
Iron Rivets	11 10 0	
Common Bars	10 15 0	
Best Bars	11 5 0	
Double Best Bars	11 15 0	
Treble Best Bars	12 5 0	
LANCS.—		
Crown Bars	10 5 0	
Second Quality Bars	8 15 0	
Hoops	13 0 0	
S. YORKS.—		
Crown Bars	10 5 0	
Best Bars	11 0 0	
Hoops	12 0 0	
MIDLANDS—		
Crown Bars	10 0 0 to 10 7 6	
Marked Bars (Staffs.)	12 10 0	
Nut and Bolt Bars	9 0 0 to 9 5 0	
Gas Tube Strip	11 2 6	

STEEL. (*d*)

	(6) Home. £ s. d.	(7) Export. £ s. d.
5) SCOTLAND—		
Boiler Plates (Marine	10 10 0	10 10 0
„ „ (Land)	10 0 0	10 0 0
Ship Plates, ¼in. and up	8 15 0	7 15 0
Sections	8 7 6	7 7 6
Steel Sheets, ¼in.	8 15 0	8 15 0
Sheets (Gal. Cor. 24 B.G.)	12 15 0	11 17 6

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	8 15 0	7 15 0
Angles	8 7 6	7 7 6
Boiler Plates (Marine	10 10 0	—
„ „ (Land)	10 0 0	—
Joists	8 10 0	7 7 6
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5s.
Hard Billets	8 2 6	—
Soft Billets	6 17 6	—
N.W. COAST—		
BARROW—		
Heavy Rails	8 10 0	—
Light Rails	8 15 0 to 9 0 0	—
Billets	6 15 0 to 9 10 0	—
MANCHESTER—		
Bars (Round)	9 7 6	—
„ (Small Round)	7 15 0 to 7 17 6	—
Hoops (Baling)	10 0 0	9 15 0
„ (Soft Steel)	9 0 0	8 15 0
Plates	8 17 6 to 9 2 6	—
„ (Lancs. Boiler)	9 15 0	—
SHEFFIELD—		
Siemens Acid Billets	9 10 0 (basis)	
Hard Basic	9 2 6 and 9 12 6	
Intermediate Basic	7 12 6 and 8 2 6	
Soft Basic	6 10 0	—
Hoops	9 15 0	—
Soft Wire Rods	8 0 0	—
MIDLANDS—		
Small Rolled Bars	7 17 6 to 8 10 0	
Billets and Sheet Bars	5 17 6 to 6 5 0	
Galv. Sheets, f.o.b. L'pool	11 17 6	
(2) Staffordshire Hoops	10 0 0	
Angles	8 7 6	
Joists	8 10 0	
Tees	9 7 6	
Bridge and Tank Plates	8 17 6	
Boiler Plates	9 12 6	—

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	18/– to 18/1½
Block Tin (cash)	138 12 6
„ (three months)	135 7 6
Copper (cash)	47 7 6
„ (three months)	47 10 0
Spanish Lead (cash)	18 5 0
„ „ (three months)	18 5 0
Spelter (cash)	15 18 9
„ (three months)	16 7 6
MANCHESTER—	
Copper, Best Selected Ingots	51 10 0
„ Electrolytic	52 0 0
„ Strong Sheets	79 0 0
„ Tubes (Basis Price), lb.	0 0 11¾
Brass Tubes (Basis Price), lb.	0 0 10½
„ Condenser, lb.	0 1 0¾
Lead, English	19 12 6
„ Foreign	18 5 0
Spelter	16 5 0
Aluminium (per ton—raw ingot)	£95

FERRO ALLOYS.

Tungsten Metal Powder	2/6 per lb.	
Ferro Tungsten	2/3 per lb.	
	Per Ton.	Per Unit.
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 12 6	7/–
„ „ 6 p.c. to 8 p.c.	£22 10 0	7/–
„ „ 8 p.c. to 10 p.c.	£22 0 0	7/–
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£33 10 0	10/–
„ „ „ 1 p.c. carbon	£38 0 0	13/6
„ „ „ 0·70 p.c. carbon	£39 0 0	15/–
„ „ „ carbon free	11d. per lb.	
Metallic Chromium	2/7 per lb.	
Ferro Manganese (per ton)	£11 15 0 for home	
„ „ „	£11 0 0 for export	
„ Silicon, 45 p.c. to 50 p.c.	£11 10 0 scale 5/– per unit	
„ „ 75 p.c.	£19 0 0 scale 7/– per unit	
„ Vanadium	12/9 per lb.	
„ Molybdenum	4/2 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£170 to £175	
Ferro Cobalt	9/6 per lb.	

FUELS.

SCOTLAND.

Prices not stable.)

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	12/6
„ „ Ell	13/6
„ „ Splint	14/6 to 16/–
„ „ Trebles	13/–
„ „ Doubles	12/6 to 13/–
„ „ Singles	12/–
AYRSHIRE—	
(f.o.b. Ports)—Steam	13/–
„ „ Jewel	16/–
„ „ Trebles	13/6
FIFESHIRE—	
f.o.b. Methil or Burntisland—Steam	10/9 to 11/9
Screened Navigation	16/6 to 17/6
Trebles	13/– to 14/–
Doubles	12/6 to 13/–
Singles	11/3
LOTHIANS—	
(f.o.b. Leith)—Best Steam	11/–
Secondary Steam	10/9
Trebles	13/– to 13/3
Doubles	12/9 to 13/–
Singles	11/6

ENGLAND.

(8) N.W. COAST—	
Steams	20/6 to 21/–
Household	32/– to 51/–
Coke	21/– to 22/–
NORTHUMBERLAND—	
Best Steams	13/6
Second Steams	12/–
Steam Smalls	10/– to 10/6
Unscreened	12/6
Household	25/– to 37/–
DURHAM—	
Best Gas	14/9 to 15/–
Second	12/9 to 13/–
Household	25/– to 37/–
Foundry Coke	24/– to 26/–

SHEFFIELD—	Inland.	
Best Hand-picked Branch	24/– to 25/6	—
Derbyshire Best Bright House	19/– to 21/–	—
Best House Coal	18/– to 19/6	—
Screened House Coal	16/– to 17/–	—
„ „ Nuts	14/– to 16/–	—
Yorkshire Hards	14/– to 15/6	—
Derbyshire Hards	14/– to 15/6	—
Rough Slacks	8/6 to 9/–	—
Nutty Slacks	7/– to 8/–	—
Smalls	3/– to 5/–	—

Blast-furnace Coke (Inland) 15/6 on rail at ovens

Furnace and Foundry Coke (Export), f.o.b. 17/– to 18/6

(9) SOUTH WALES.

CARDIFF—	
Steam Coals :	
Best Smokeless Large	20/–
Second Smokeless Large	18/9 to 19/9
Best Dry Large	18/6 to 18/9
Ordinary Dry Large	17/6 to 18/–
Best Black Vein Large	18/3 to 18/6
Western Valley Large	18/– to 18/3
Best Eastern Valley Large	17/9 to 18/–
Ordinary Eastern Valley Large	17/6 to 17/–
Best Steam Smalls	13/6 to 13/9
Ordinary Smalls	11/6 to 12/9
Washed Nuts	19/– to 22/–
No. 3 Rhondda Large	20/– to 20/6
„ „ Smalls	15/6 to 16/–
No. 2 „ Large	17/– to 17/3
„ „ Through	16/– to 16/6
„ „ Smalls	14/– to 14/3
Foundry Coke (Export)	27/6 to 37/–
Furnace Coke (Export)	21/– to 21/6
Patent Fuel	22/–
Pitwood (ex ship)	26/– to 26/6
SWANSEA—	
Anthracite Coals :	
Best Big Vein Large	35/– to 37/6
Seconds	27/– to 31/6
Red Vein	23/6 to 27/–
Machine-made Cobbles	41/6 to 45/–
Nuts	40/– to 46/–
Beans	24/6 to 27/6
Peas	21/– to 21/6
Breaker Duff	10/– to 10/6
Rubbly Culm	11/3 to 11/9
Steam Coals :	
Large	19/6 to 21/6
Seconds	18/– to 19/6
Smalls	12/– to 13/–
Cargo Through	15/6 to 16/–

(1) Delivered. (2) Net Makers' Works. (3) f.o.b. Makers' Works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire, and Ayrshire. (6) Home Prices—All delivered Glasgow Station. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (*a*) Delivered Glasgow. (*b*) Delivered Sheffield. (*c*) Delivered Birmingham. (*d*) Rebate: Joists (minimum), 12/6; Ordinary Ship, Bridge, and Tank Plates and Sections, 10/– if home consumers confine purchases from associated British Steel Makers. (*e*) Delivered Black Country stations.

French Engineering Notes.

(From our Correspondent in Paris.)

The Steel Cartel.

THE meeting of the Steel Cartel to be held during the month will deal with the most critical situation in its history. It has long been affirmed that the renewal of the Cartel at the end of the year would depend upon the creation of international sales comptoirs, which would maintain minimum prices for export. With a great deal of trouble two comptoirs were formed for partly manufactured steel and rolled steel sections, but after a short trial the minimum prices have been withdrawn. Price cutting began when some of the mills found that they must get orders or close down and, more especially, when British producers offered steel at below the continental minimum. That has aroused a good deal of recrimination amongst the French and Germans, as it is affirmed that some of the French mills are largely responsible for the failure of the minimum scale of prices, and the Germans insist that the Steel Cartel is doomed. The French are more anxious than anyone else to renew the Cartel and to maintain the comptoirs, even without the minimum, partly because the comptoirs assure them the largest quota of foreign trade, and it is certain that a collapse of both the Cartel and the comptoirs would have disastrous effects for the continental steel industry. The French would do everything possible to maintain the comptoirs and the Cartel, for, even though a lack of cohesion might render them ineffective, as a means of stabilising the steel industry, the organisation would still exist, and might be reinforced when circumstances compelled steel makers to accept a control of prices for their common good. While German steel producers state that the failure of the comptoirs implies a failure of the Cartel, the French refuse to admit that the Cartel cannot stand alone. This discussion is largely influenced by the disturbing question of quotas. The Germans are not satisfied with what they have got, nor are the Belgians, and there is a danger of the Cartel succumbing to conflicting interests. Meanwhile the suppression of minimum prices will free the hands of the Semi-Steel Products Corporation of Belgium, which has been formed by a group of Belgian steel makers for the sale of partly manufactured steel in Great Britain.

Wagon Builders' Union.

A meeting is to be held shortly at Lucerne to settle the final details of the International Wagon Builders' Union, which has been in operation for some time and includes all the continental countries, except Poland and Roumania. All attempts to induce British wagon builders to join the Union have failed, but negotiations are to be continued with a view to securing their adhesion, as well as that of the two other countries remaining outside.

The New Liner.

By the terms of its original agreement with the State, the Compagnie Générale Transatlantique was to have had the proposed new liner ready for the Havre-New York service next spring, but owing to the ship's dimensions work could not be started upon it until there was some assurance that the *forme entrée*, or combined graving dock and lock, at Saint-Nazaire would be completed in time to allow of the ship leaving the Penhoët yard. At the same time, the channel at Havre will have to be deepened and the landing stage at New York lengthened. Work on the lock at Saint-Nazaire is proceeding, and the liner will be put on the stocks in the coming spring, so that it may be ready for service in 1934. Its displacement will be about 60,000 tons. The length will be 306 m. and width 35 m. At first it was proposed to generate steam with oil burners, but it is understood that that idea has been abandoned and that coal will be used. It is probable that Government has been guided by a question of national security in selecting the use of solid fuel for the new liner, since there is no certainty of the country obtaining adequate oil supplies in case of hostilities. The new liner, which will probably be named "La Paix," will replace the "France."

The Northern Canal.

The Roubaix Chamber of Commerce i as come to a decision definitely in favour of constructing a canal between the Lille-Roubaix-Tourcoing area and Dunkirk with a view to providing facilities for traffic with that port instead of sending goods by way of Antwerp. It therefore approves of the scheme which Dunkirk has endeavoured to get adopted for many years past for the construction of a canal that will divert to it most of the traffic from the industrial centres of the North. Roubaix goes still further, and proposes that the canal shall allow cargo boats of 1000 tons reaching Lille, which would become an inland port, and by extending the waterway eastward it would secure much of the freight that at present goes by the Rhine to foreign ports. It is proposed to make the canal 50 m. wide and sufficiently deep to provide for a draught of 6 m. The undertaking can only be financed by the State, which has already as many works in hand as it can deal with for the time being.

Engineers' Status.

A Bill has been introduced into Parliament for determining the status of engineers, and deciding whether the appellation of engineer is to remain free or whether it will be strictly reserved for those possessing engineering diplomas. The Bill is the outcome of years of discussion, and the matter continues to be debated in a way that shows how difficult it is to arrive at a satisfactory solution. The necessity of protecting qualified engineers is self-evident, but the difficulty arises from the fact that the profession is becoming more and more specialised and that there are plenty of self-trained men who are doing good work in particular branches of engineering. At the same time, every engineer must have moral qualifications and a good scientific instruction as well as practical training, and the new measure provides how that is to be done by the existing State institutions, universities, and private engineering schools.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgement is not illustrated the Specification is without drawings.

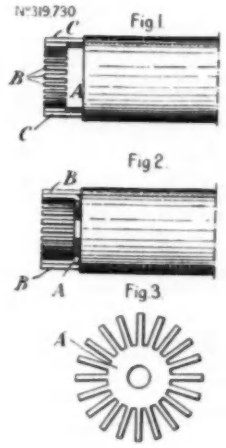
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgement, is the date of the acceptance of the complete Specification.

DYNAMOS AND MOTORS.

319,730. August 1st, 1929.—INDUCTION MOTORS, Sachsenwerk Licht-und Kraft-Aktiengesellschaft, of Niedersedlitz, Dresden, Germany.

In the manufacture of electric induction motors a difficulty frequently arises in welding squirrel-cage armatures in that the two parts to be welded together—the short-circuiting ring and the conductor—are of different cross section, and therefore have different capacities for conducting heat. The thin conductor therefore melts, while the thick short-circuiting ring still remains solid, so that a good welding joint cannot be obtained. In order to obviate this difficulty, it is the usual practice to divide the short-circuiting ring into several rings of smaller cross section, and to weld each of such rings to the conductors of the squirrel-cage armature. The number of rings of the welding joints necessary is therefore greatly increased, with a consequent

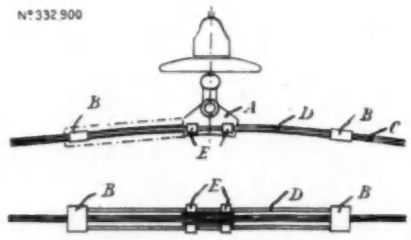


increase in the cost of manufacture. According to this invention, a different method is adopted. The short-circuiting ring is divided at the points at which the welding is to take place into comparatively long teeth forming axially directed conductors, the cross section of which is not much greater than that of the squirrel-cage bars, so that the welding is easily effected. The accompanying drawings show two constructions according to the invention. Fig. 1 shows a short-circuiting ring A, which is of cylindrical shape, one end of which is formed with comparatively long teeth B that are welded to the bars C of the squirrel-cage armature. Fig. 2 shows a squirrel-cage armature with star-shaped short-circuiting discs A. The original shape of the discs A is shown in Fig. 3, the radial teeth being bent to an angle of about 90 deg., so that, as shown in Fig. 2, they are parallel to the axis of the armature and can be welded to the bars B of the squirrel-cage winding.—*August 7th*, 1930.

TRANSMISSION OF POWER.

332,900. April 27th, 1929.—APPARATUS FOR DAMPING THE OSCILLATIONS OF ELECTRIC CONDUCTORS, Johannes Wilhelm Hofmann, trading as the Firm J. Wilhelm Hofmann, of Koetzschenbroda, near Dresden, Saxony.

With a view to damping mechanical oscillations in overhead lines, supplemental clamps B are arranged at a certain distance from the fastening points A and firmly fastened on the line cable C by clamping, the clamps being connected with the fastening points A by bars D, which are adapted in their dimensions to

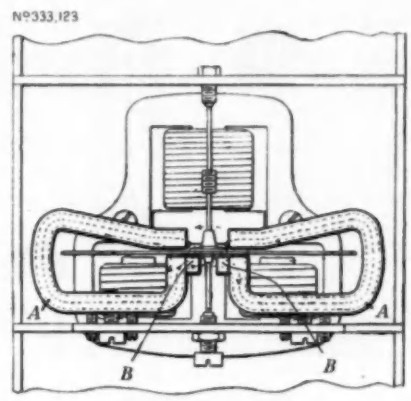


different sections of the line. For supporting clamps the supplemental clamps B are arranged on both sides of the supporting clamp, but, for stretching clamps, only on the side of the stretched line. These bar-like connecting parts D may be arranged in corresponding projections E of the supporting or stretching clamps loosely or tightly. The damping effect of the bars D is greater when the bars are fastened by screws on the clamps A and B. The effect of the bars will, however, be reduced if the fastening is effected only on the clamp A or on the clamp B. A modification of the scheme is also described.—*July 28th*, 1930.

MEASURING AND TESTING INSTRUMENTS.

333,123. November 12th, 1929.—ALTERING THE TEMPERATURE ERROR IN INDUCTION ELECTRICITY METERS, Landis and Gyr S.A., of Hofstrasse 1, Zug, Switzerland.

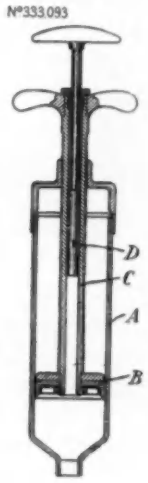
This specification describes a device for varying the temperature error in induction electricity meters by the employment of metals having coefficients of permeability dependent on the temperature. At the end of each magnet A there is a piece of metal B of this description. As the permeability of these metal pieces varies with the temperature, there is a variation in the magnitude of the braking flux and the temperature error of the instrument is compensated. The specification states that the



metal pieces A may consist of alloys of different composition, but no definite information concerning the composition is given. —*August 7th*, 1930.

MACHINE TOOLS AND SHOP APPLIANCES.

333,093. September 30th, 1929. —HIGH-PRESSURE GREASE GUNS, J. E. M. Seguin, 60, Rue Dombasle, Paris.

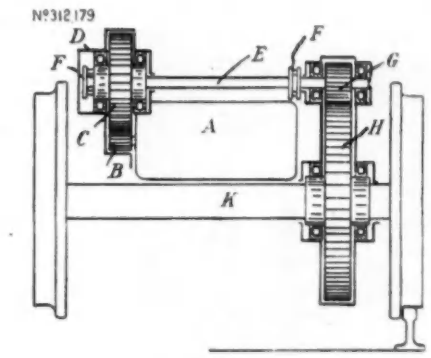


This grease gun is intended to provide a supply of lubricant at a high pressure, and at the same time have a reasonable storage capacity. The container A has a main piston B, which may be screwed down on its stem C to push forward the grease. Within the hollow stem of this piston there is another piston D of small diameter that can be used to feed the lubricant at a high pressure. The process is made step by step; that is to say, as the large piston B is screwed down, the small piston D recedes under the internal pressure of the grease. The small piston is then used to make the charge and the cycle is repeated if necessary.—*August 7th*, 1930.

TRAMWAYS AND RAILWAYS.

312,179. May 21st, 1929.—DRIVING ARRANGEMENTS FOR ELECTRICALLY PROPELLED VEHICLES, *International General Electric Company, Inc., of* 120, *Broadway, New York.*

This invention relates to driving arrangements for electrically-propelled vehicles. In such arrangements as hitherto proposed, a cardan or flexible joint has been interposed between the driven axle and the motor, the latter being disposed longitudinally of the vehicle frame and transmitting its power through a bevel gear. With such an arrangement the drive occupies considerable space in the direction of the length of the vehicle, and cannot be used in vehicles having a short wheel base, such, for example, as electric tramcars. The invention has for its object to provide a driving arrangement in which this disadvantage is



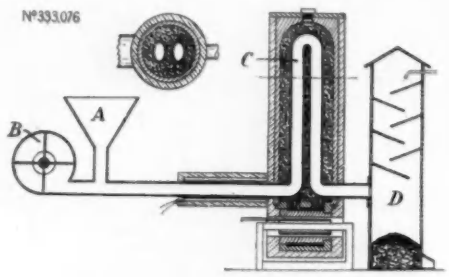
obviated. The motor A is rigidly suspended in the shock-absorbing frame of the vehicle. The motor pinion B engages with the transmission gear wheel C, which is mounted in a protecting casing D by means of roller bearings. This toothed wheel C is bored large enough for the intermediate shaft E of the transmission gearing to pass through it with play. The shaft E is connected to the toothed wheel C by means of a cardan joint F, a coupling flexible in every direction. On the other side, the shaft E is also connected to the shaft of the toothed pinion G, by means of a cardan joint F. The pinion G transmits the drive to the gear wheel H and thus on to the driving axle K. The vibrations due to inequalities in the rails are taken up by the flexible mounting of the shaft E and kept away from the motor and its parts.—*August 7th*, 1930.

METALLURGY.

333,076. September 9th, 1929.—THE SEPARATION OF ALKALIS FROM SILICEOUS MATERIALS, P. E. Billinghurst, Pointe du Bois, Manitoba, Canada.

This invention is concerned with the extraction of alkalies of the lithium and potassium group from siliceous materials, such as spodumene and feldspar, on a large scale. The rock is first reduced to a powder and is blown from a hopper A by means of a fan B into a U tube C which is heated by an electric

induction furnace. On its way the dust is preheated to a temperature of 450 deg. Cent. In the U tube the temperature is raised to from 1500 deg. to 1800 deg. Cent. The alkalies are

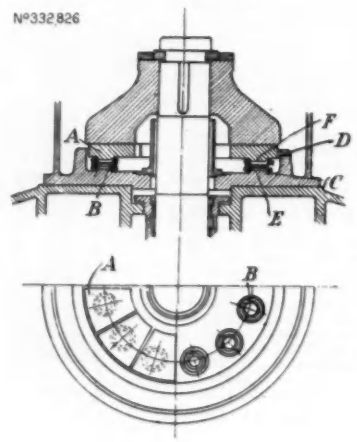


consequently volatilised. The whole mass is blown into the tower D, where the siliceous material settles down and the alkalies are leached out with water.—*August 7th*, 1930.

MISCELLANEOUS.

332,826. October 8th, 1929.—VERTICAL THRUST BEARINGS, Aktiengesellschaft Brown, Boveri & Cie., of Baden, Switzerland.

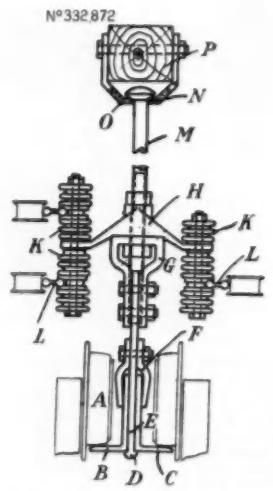
This specification describes a spring-supported vertical thrust bearing for heavy loads, characterised by the employment of annular springs having interchanging conical seating surfaces, the springs being such that no substantial variation in their axial length occurs with variations of load from the state of rest



to that of maximum load. The stationary race A of the thrust bearing described in this specification is divided into segments, and each separate segmental part is supported by conically interengaging, annular springs B. The base plate C and the lower surface D of the segmental parts are provided in accordance with the size of the annular springs with projecting guides E and F, in order to prevent the springs from being displaced.—*July 31st*, 1930.

332,872. December 13th, 1929.—RUNWAYS, Demag Aktiengesellschaft, of 64, Werthauserstrasse, Duisburg, Germany.

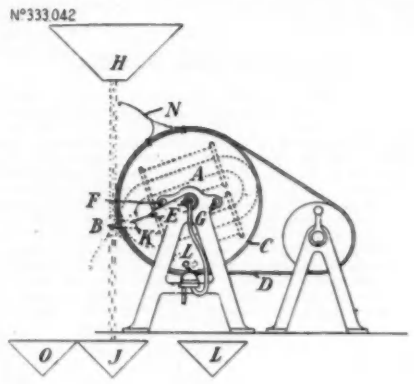
The runway according to the specification differs from known types particularly by reason of the fact that it consists of section iron secured only by clamps and suspended from the traction members. Thus existing section iron can be employed, and the working up, such as the drilling of this section iron is unnecessary. The travelling member or crab A runs on the angle rails



B C. The vertical stresses are transferred to projections D on a tension member E. Lateral stresses are taken up by the plates F. The member G carries the holder H for the current rails. The holder carries insulators K in the usual manner, the current rails L being securely clamped between them. At its upper end the bar M has an approximately spherically cap-shaped knob N, by which it is held in a fork fitting O secured to a carrier P. —*July 31st*, 1930.

333,042. July 24th, 1929.—MAGNETIC SEPARATORS, Oswald Charles Jones, of 9, Mill-street, Maidstone.

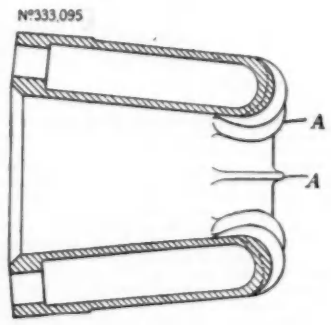
The machine illustrated is especially designed for the treatment of semi-liquids, and comprises a number of electro-magnets of approximately horse-shoe shape assembled together to form an elongated compound magnet A having a gap B in the direction of its length equal in width to the space between the poles of each magnet. The magnets are held in a casing or cylinder C, which is mounted between bearings, so that the casing and magnet are capable of being rocked or partly rotated by means of a belt D within the limits of two stops. The material to be treated is caused to flow from the hopper H over the surface of the belt and assuming that the poles of the electro-magnet are energised and in the position shown with the controlling arm E against the stop F, then magnetic particles will be attracted and adhere to the surface of the belt at B, the separated material falling into a receptacle J. Upon the electro-magnet being rocked in its bearings by means of the belt, the extension K of the arm E will wipe the handle of the switch L to its "off" position, thus de-energising the magnet and causing magnetic



particles adhering to the surface of the belt to be discharged into a receptacle L, the discharge being assisted when the belt and cylinder are brought suddenly to rest by the arm E attached thereto engaging the stop G. The backward rocking movement of the belt and arm E will automatically switch on the current and bring the magnetic field to the normal position under the flow of material to be treated. In order to ensure that no magnetic particles escape into the receptacle J provided for the separated material during the process, the belt and cylinder are provided with a fin or shield N which cuts off or deviates the flow of material into a third receptacle O during the short time the cylinder is being rocked to discharge the accumulation of magnetic material.—*August 7th*, 1930.

333,095. October 1st, 1929.—TUYERES FOR BLAST-FURNACES, F. D. Brown, Norton Priory, Stockton-on-Tees, G. B. Richards, 68A, Hill Top, West Bromwich, and T. J. Roberts, 20, Cornfield-road, Middlesbrough.

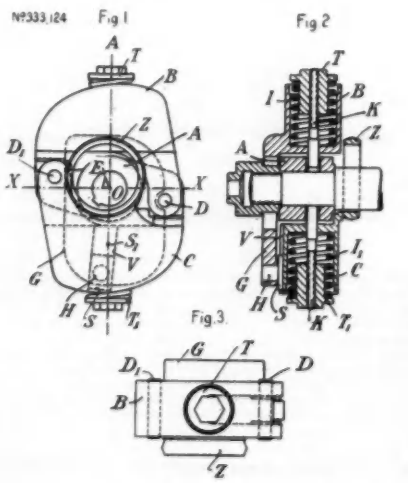
The inventors suggest that the wastage of blast-furnace tuyeres



at their outlet is caused by the production of vortices in the blast. As a consequence, they provide ribs A A on the casting, near its mouth, which are claimed to check the development of such vortices and thus increase the life of the tuyere.—*August 7th*, 1930.

333,124. November 18th, 1929.—SHAFT GOVERNORS FOR POWER MACHINES, A. Becker, 30, Westerstrasse, Bremen, Germany.

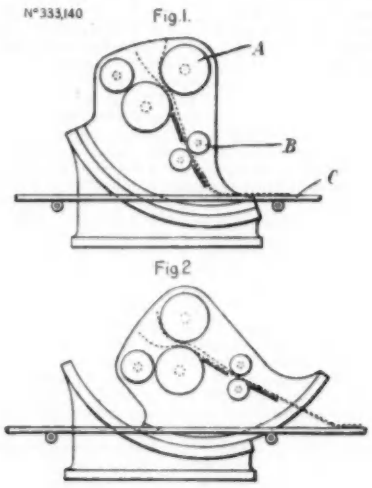
This invention relates to a shaft governor of the kind comprising two centrifugal, spring-controlled weights which are mutually articulated so as to perform equal deflecting movements, one of the weights carrying an excentric, and the invention consists in connecting the two weights, by means of a block



which is pivoted to a rigid arm on one weight and arranged to slide in a slot in the other weight. Keyed to the crank shaft of the machine is a boss A provided with two diametrically opposed radial arms carrying pivots D and D^1, whereon centrifugal weights B and C respectively are mounted. The weights are slotted for the reception of controlling springs I and I^1 respectively, which are adjustable by means of headed nuts T and T^1 mounted on a screw spindle K. The weight C is formed with a slot V wherein a block S is slidably guided and this block is connected by means of a pivot H to an arm G on the weight B, the two weights being thus coupled so as to perform equal deflecting movements. The pivot H may be secured either to the arm G or to the block S. The weight C carries an excentric Z which is counterbalanced by the arm G. The weights are shown in the drawings in their normal positions, the excentricity E—O of the ring Z being at its maximum. The point E and the centre of gravity S^1 of the weight C are at opposite sides of the central transverse axis X—X of the structure.—*August 7th*, 1930.

333,140. February 10th, 1930.—GLASS ROLLING TRAINS, Y. Brancaert, Verreries de Fauquez, Ronquières, Belgium.

It is usual in rolling plate glass to pass the molten glass successively through two pairs of rolls A and B, and to lay the resultant sheet on a travelling table C. The passes through the two sets of rolls are set at an angle of about 45 deg., but it is desirable



that this angle should be variable to suit different thicknesses and consistencies of glass. The inventors consequently mount the whole train of rolls and their driving motors on an arc-shaped frame, which can be adjusted in position. Fig. 1 shows the machine set for making thin plate glass and Fig. 2 for making thick plates of very fluid glass.—*August 7th*, 1930.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

INSTITUTE OF METALS.—Annual Autumn Meeting, Southampton. Continued from September 13th to September 16th by a visit to France. 8 p.m. For programme see page 88.

SATURDAY, SEPTEMBER 13TH, TO SATURDAY, SEPTEMBER 20TH.

LIVERPOOL.—Centenary celebrations of the Liverpool and Manchester Railway.

SUNDAY, SEPTEMBER 14TH, TO WEDNESDAY, SEPTEMBER 17TH.

NEWCOMEN SOCIETY.—Summer meeting at Liverpool.

WEDNESDAY, SEPTEMBER 17TH.

INSTITUTION OF CIVIL ENGINEERS: BIRMINGHAM AND DISTRICT ASSOCIATION.—Visit to the works of Ham, Baker and Co., Ltd., Langley Green, Birmingham. 2.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS: YORKSHIRE BRANCH.—Visit to the London and North-Eastern Railway Locomotive and Carriage Works, Doncaster. 2.30 p.m.

WEDNESDAY, SEPTEMBER 17TH, TO WEDNESDAY, OCTOBER 1ST.

BUILDING TRADES EXHIBITION.—At Olympia, London.

FRIDAY, SEPTEMBER 19TH, TO SUNDAY, SEPTEMBER 21ST.

WOMEN'S ENGINEERING SOCIETY.—Lady Margaret Hall, Oxford. Eighth annual conference.

TUESDAY, SEPTEMBER 23RD.

INSTITUTE OF MARINE ENGINEERS.—85–88, The Minories, Tower Hill, London, E.C. 3. Presidential address, by Lieut.-Commander Sir August B. T. Cayzer, Bart. 6 p.m.

THURSDAY, SEPTEMBER 25TH.

INSTITUTION OF LOCOMOTIVE ENGINEERS.—296, Vauxhall Bridge-road, S.W. 1. Presidential address by Mr. H. Kelway Bamber. 6 p.m.

FRIDAY AND SATURDAY, SEPTEMBER 26TH AND 27TH.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Southern District meeting at Southampton. Friday: 10 a.m., assemble at Audit House. Official welcome by the Mayor of Southampton, Mr. Councillor H. Young. Description of works by Mr. S. G. Stanton, Borough Engineer and Surveyor and Housing Architect. 11 a.m. to 1 p.m., visits to various works being carried out by the Corporation. 1.30 p.m., arrive at South-Western Hotel for lunch by the invitation of the Mayor and Corporation. Saturday: 9.30 a.m., assemble at South-Western Hotel. Discussion on paper, "Municipal Undertakings." 11 a.m., inspection of Southern Railway Company's new dock works, Western Esplanade. 1 p.m., luncheon at South-Western Hotel. 3 p.m., assemble at the Ocean Dock, Entrance No. 2 Gate, Southampton Docks, for an inspection of R.M.S. "Majestic."

FRIDAY, OCTOBER 3RD.

JUNIOR INSTITUTION OF ENGINEERS.—In the Lecture Room of the Institution at 39, Victoria-street, S.W. 1. "The Development of the Bridge," by Mr. S. J. Crispin. 7.30 p.m.